Silver Sunshine
INSECT EDITION

PUBLISHED BY

CANADIAN SUGAR FACTORIES
RAYMOND - ALBERTA

AND

SCIENCE SERVICE LABORATORIES
LETHBRIDGE - ALBERTA

FOR

THE SUGAR BEET PRODUCERS
OF WESTERN CANADA

SILVER SUNSHINE

Published by the Agricultural Department, Canadian Sugar Factories Ltd.

VOLUME XV INSECT EDITION, 1956

EDITORIAL

Insect Control Recognized by Special Edition

Frank R. Taylor
General Manager, Canadian Sugar Factories Limited

The history and development of the Sugar Beet Industry on the American Continent is dotted with stories and experiences resulting from the infestations of pest and disease. Factories have been closed temporarily, others moved away, and entire beet areas have been abandoned. In many cases it was for lack of immediate information re economical control.

The Sugar Beet Industry's coming into Alberta in 1925 can be partially attributed to the disease "curly top", resulting from leafhopper or "white fly" in the desert areas of Western Idaho and Washington. Plants in the lower Snake River Valley of Idaho and in the Yakima River Valley of Washington were sitting idle for the reason that the era of curly top resistant strains had not arrived. The result was that the Beet Sugar Factories were moved away to new disease-free locations at Raymond, Alberta, Chinook, Montana, and Bellingham, Washington. Also during the same period, one factory from Delta, Utah, went into South Dakota at Belle Fourche.

Prior to this exodus the sugar beet nematode was making it rough going in parts of California and Utah. This was largely the result of the inroads of "blight", which in the early days was the farmer's expression for nematode infestation.

The writer, in the years immediately following World War I, assisted Dr. E. H. Titus, of the U.S.D.A., and Gerald Thorne, U.S.D.A., now Chief Nematologist with headquarters in Salt Lake City, in mapping nematode areas and charting rotation results in the Provo, Utah, beet districts supplying beets to the Lehi factory.

Editorial - continued

As curly top was literally wiping out crops in the desert areas and invading the inner valleys, nematode was forcing farmers in all the older district to abandon beet lands in favor of forage and cannery crops, beets disappeared, and with them the factories.

The nematode history of U.S. districts made Company Officials extra wary of infestation in Alberta. Foreign seed was re-cleaned of dirt balls and a keen eye kept open for sources of infestation. A strict rotation program was instituted. To date no curly top or sugar beet nematode has been noted in Alberta.

Over the years the incidence of cutworms, wireworms, army-worms, webworms, leaf miner, false chinch bugs, carrion beetles, flea beetles, etc., have all taken a bat at the already very busy beet grower.

Patched in among the attacks of the above are other more pernicious pests such as root aphis, root maggot, and the various seedling diseases. They are still with us.

Through the years of the beet development in the U.S. and Canada, many men have contributed to the success of the industry in combatting pests and disease. To mention names is unfair to the many who have contributed, but the writer does feel that one man, Mr. Asa C. Maxson of the Great Western Sugar Company, deserves the most sincere thanks and appreciation of the beet industry for his practical compilations and control recommendations developed and used successfully for so many years.

The seriousness to the economy of beet production in Canada can be visualized by the summary of damage and loss to Alberta crops in 1955. This is submitted by the Company's Agricultural Department after a careful survey of losses.

Flea beetles affected 8 to 10 thousand acres, of which 4000 were treated, with an estimated loss of 8000 tons. Of the 15,000 acres that were treated for **Webworm,** 1000 were damaged severely. The estimated loss in yield was 7500 tons. The cost of treatment material was approximately $2.50 per acre. **Root maggots** affected a considerable acreage in the Taber-Cranford area, with a loss estimated at approximately 6500 tons. Losses ranged up to almost complete failure in some fields. Total estimated loss is 22,000 tons, or an average of .58 tons per planted acre. These losses run into fabulous figures.

The Canadian Sugar Factories and the Manitoba Sugar Company Agricultural Departments and the staff of "Silver Sunshine," having in mind 1955 losses to the Beet Industry from pests, have combined with the staff of the SCIENCE SERVICE LABORATORY in Lethbridge to publish this edition. It was thought that a compiled treatise on the subject of pests of the sugar beet merited a convenient ready reference for grower's use.

The Companies and "Silver Sunshine" wish to express thanks and sincere appreciation to all who have assisted with this publication, particularly the contributions from the Science Service Staff, and especially Dr. W. C. Broadfoot, Director, and Dr. C. W. Farstad of the Field Crop Insect Section. Its value will be in the practical application of the information.

Department Heads of the Canadian Sugar Factories Ltd. and Manitoba Sugar Co., Responsible for Agriculture and Agricultural Research Divisions

F. H. PETO
Research Director

J. G. SNOW
Gen. Agr. Supt.
C. S. F. Ltd.

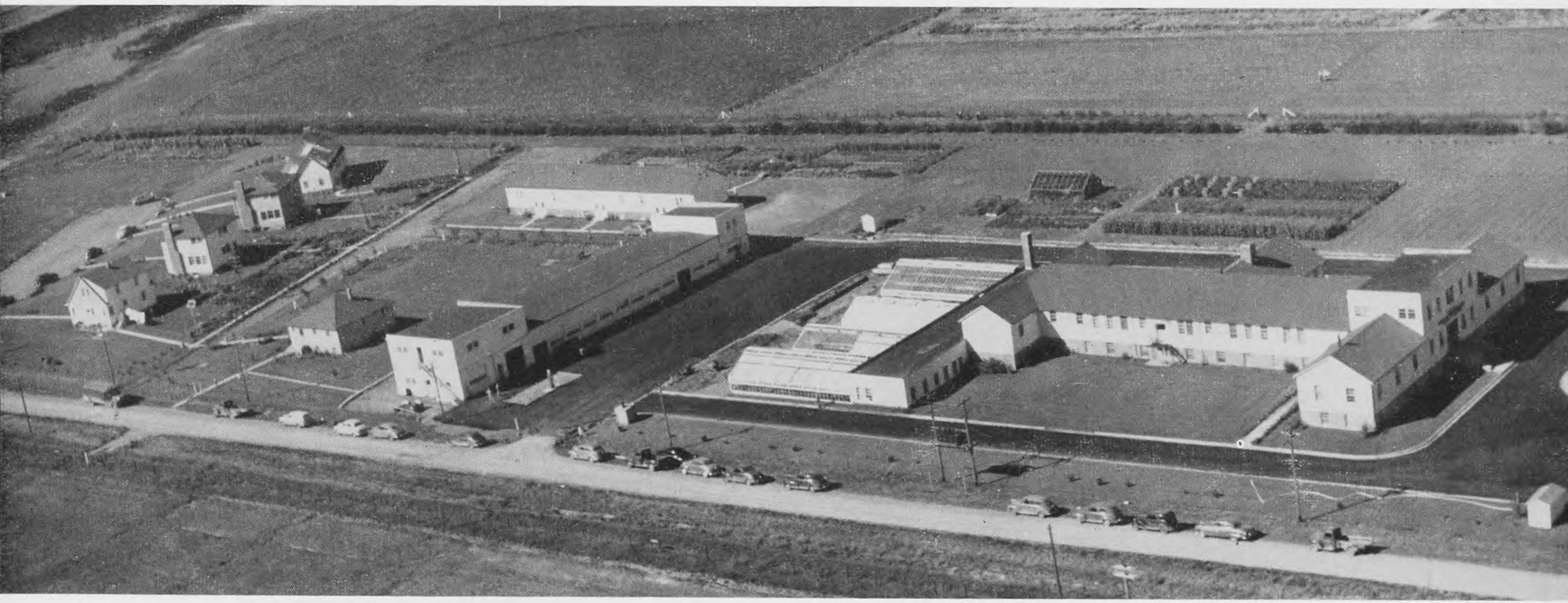
J. W. HALL
Agr. Supt.
Man. Sugar Co.

K. E. PILLING
Agr. Supt.
C.S.F., Pic. Butte

R. B. EVANSON
Agr. Supt.
C.S.F., Taber

W. G. SMITH
Research Geneticist
C.S.F., Taber

K. SCHREIBER
Agronomist
Man. Sugar Co.



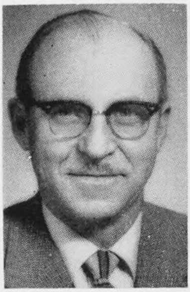
—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

SCIENCE SERVICE LABORATORY, LETHBRIDGE, ALBERTA

Functions of Field Crop Insect Section of the Science Service Laboratory

C. W. Farstad

Officer-in-Charge, Field Crop Insect Section
Science Service Laboratory, Lethbridge, Alberta



Dr. Farstad received a B.Sc. degree in biology and an M.Sc. in Entomology from the University of Saskatchewan and a Ph.D. in Zoology from Iowa State College. He has studied several of the major insect pests of Alberta, was for many years head of research work on the wheat stem sawfly in Western Canada, and in 1948 was made Officer-in-Charge of the Field Crop Insect Section of the Science Service Laboratory at Lethbridge.

The primary functions of the Field Crop Insect Section staff are to study insects attacking farm crops and to advise farmers how best to deal with these problems when they arise. There is no crop that is not subject to attack by one or more species of insects. In both time of year and location of feeding, insects differ in the way in which they attack a crop, i.e., they feed on the roots, on the leaves, on or inside the stems, and even inside the seeds. Sometimes the adults cause the damage; other times the immature grubs and nymphs are the villains. Therefore, each group of insects must be thoroughly studied before satisfactory recommendations can be made for the grower.

The insect problems associated with sugar-beet production in Alberta and Manitoba have been unspectacular compared with those in sugar-beet-growing areas in the United States and Europe. So far we have been extremely fortunate in not having had some of the major diseases that are transmitted by leafhoppers and aphids. We have yet to find the sugar-beet nematode. How long we shall be free of these more serious pests is problematic. We are continually on the lookout for these or any other entirely new insect problems associated with farm crops.

Although the pests now occurring in our own area are not as serious nor as difficult to control as those occurring in other parts of the world, we cannot be complacent. In 1955, with no really spectacular outbreak, the growers in Alberta lost 22,000 tons of sugar beets valued at approximately a quarter of a million dollars. Each insect species that attacks the growing plant gives it a setback and affects the final tonnage per acre. The job of every grower then

must be to take every precaution to reduce insect damage so as to increase his per-acre production. INSECT CONTROL IS OFTEN THE BEST INVESTMENT A GROWER CAN MAKE.

Sometimes we are a bit hesitant in organizing and recommending large-scale chemical control programs because of the danger of upsetting "nature's balance." Some of the newer insecticides kill all species of insects. If these extremely poisonous chemicals were recommended, the useful insects as well as the pests might be destroyed and the control program would backfire. Consequently, in making recommendations for the use of insecticides, we try to adjust the application so as to control the pest and do as little harm as possible to the beneficial insects.

One of the services that the Field Crop Insect Section is responsible for is insect surveys. Each year field crops, forage crops, gardens, and beet fields are examined and appraisals of insect numbers made so that we may be able to give warning of an approaching outbreak. It is therefore possible for manufacturers and distributors to lay in supplies of insecticides for immediate distribution when the most appropriate stage for control arrives. Also, the rotation pattern may be adjusted in such a way that insect and disease losses may be reduced to a minimum.

This issue of SILVER SUNSHINE has been compiled by the men whose special fields are the study of insects, diseases, and cropping practices. It is an attempt to provide the beet grower with a handbook that he will find useful in identifying and controlling the various crop pests that he will find in his day-to-day work on the farm.

Research is an organized method of finding out what you are going to do when you can't keep on doing what you're doing now. It is a state of mind.

—Charles F. Kettering

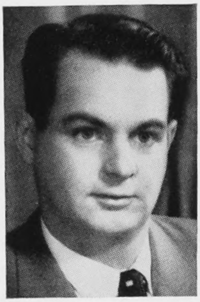
The work of science is to substitute facts for appearances and demonstrations for impressions.

—John Ruskin

Some Facts About Insects

A. M. Harper

Field Crop Insect Section
Science Service Laboratory, Lethbridge, Alberta



Mr. Harper received his B.Sc. in Agriculture and M.Sc. in Entomology from the University of Alberta and expects to obtain his Ph.D. in zoology in 1956 from Washington State College. He is conducting research on the sugar beet root aphid and several related aphid species found in southern Alberta.

Insects affect our lives more than most of us realize. Nearly all our food and clothing comes from plants and animals, and practically no plants or animals are completely free of insects.

Approximately 700,000 kinds of insects have been named and described, and every year a few hundred more are discovered. In Western Canada there are many thousands of insects present but surprisingly few are serious pests.

It is important that scientists and farmers know as much as possible about insects so that they can control the pests, permit the beneficial insects to increase, and predict what insect problems may be caused by modifying agricultural practices.

DAMAGE BY INSECTS

Insects take a heavy toll of crops, livestock, stored foods, and clothing. The most obvious losses are those caused by feeding of insects, but animal and plant diseases transmitted by insects cause a greater loss.

In our own area we have stored grain damaged by grain mites and rusty grain beetle; garden crops damaged by cutworms, wireworms, grasshoppers, flea beetles, and aphids; and animals affected by warble flies, horn flies, and blow flies.

In Canada it is estimated each year that the losses caused by insects amount to 300 million dollars, which is more than the cash income from all farm products in Manitoba or from fields crops in Alberta.

BENEFITS FROM INSECTS

When considering the economic importance of insects the benefits to man are frequently overlooked.

Those insects that attack the injurious species are an extremely important group.

Another important group of insects pollinates flowers while visiting them for nectar and pollen. Such plants as clovers, peas, beans, and melons require insects' visits before seeds or fruits can form.

Other insects are responsible for a number of commercial products such as silk, honey, beeswax, and shellac.

Wildlife feeds on insects, and in some parts of Australia, Africa and Asia, grasshoppers, crickets, and caterpillars are eaten by the natives.

HOW INSECTS FEED

Biting and chewing insects. These insects are equipped with a pair of powerful, toothed jaws, which move sideways instead of up and down as do our own. The teeth are at the front of the mouth, and when the jaws are brought together, the insect can bite pieces of leaf or other food material, which can then be pushed into the mouth itself. Common biting insects are: grasshoppers, caterpillars, and larvae and adults of beetles. This type of insect can be controlled by application of certain poisons to the leaves on which the insect is feeding.

Insects with piercing and sucking mouths. These insects have their mouth parts modified into a structure that resembles a hypodermic needle. They pierce small holes in the surface of leaves or in the skin of animals and suck the sap or blood. They can pierce leaves that are sprayed with poisons such as arsenic and feed on the inner parts of the plant, which contain no poison and so escape death. However, some poisons enter the breathing pores and kill these insects (fumigants). Others kill the insects if they get on the insects' bodies (contact poisons). Another group of chemicals are absorbed by the plants and move in the sap stream of the plant (systemic poisons); these are especially useful for insects with piercing and sucking mouths. Common sucking insects are: aphids, leafhoppers, fleas, and scale insects.

CONTROL OF INSECTS

Insect control refers to those factors that prevent the spread and reduce the abundance of insect pests. Natural control refers to

those factors that do not depend on man for success, while artificial control depends on man.

Natural Control. Insect populations are affected by many factors, including (1) weather and climate, such as temperature, humidity, air movement, (2) topography, such as land and water barriers, soil texture, and composition, (3) parasites and predators, that is, insects or other animals that feed on insects, and (4) diseases (viruses, fungi, and bacteria). When no disturbing influence is introduced by man or other agencies, the insect population tends to be held in balance by these factors.

Artificial Control. When insects cause serious damage to crops man must resort to controls such as summerfallow, crop rotation, change in tillage methods, variation in time of planting, destruction of crop residue and weeds, use of resistant varieties, stimulation of vigorous growth, controlled irrigation, introduction of parasites and predators, and use of insecticides.

There are some things that all human beings have in common. One of these—perhaps the most important—is the capacity for suffering. We have it in our power to diminish immeasurably the sum of suffering and misery in the world, but we shall not succeed in this while we allow opposite irrational beliefs to divide the human race into mutually hostile groups. A wise humanity, in politics as elsewhere, comes only of remembering that even the largest groups are composed of individuals, that individuals can be happy or sad, and that every individual in the world who is suffering represents a failure of human wisdom and of common humanity.

The aims of statesmanship should not be abstract. They should be as concrete as the affection of parents for young children. The world needs wisdom and human warmth in equal measure. Both are lacking at the moment, but not, one may hope, forever.

—Bertrand Russell

Sugar-Beet Webworm

G. E. Swailes

Field Crop Insect Section

Science Service Laboratory, Lethbridge, Alberta

Mr. Swailes received his B.Sc. in Horticulture at the University of Manitoba and his M.Sc in Entomology at Colorado A. & M. He expects to complete his Ph.D. in Zoology at Iowa State College in 1956. Mr. Swailes formerly studied aspects of the biology of the sugar beet webworm in southern Alberta and is at present in charge of turnip maggot research.

It is seldom that sugar beets in southern Alberta do not suffer some damage from webworm. The two broods, one in May and June and the other in August, can both cause reduction in yield and sugar content.

DESCRIPTION AND LIFE HISTORY

The **adult** webworm is a moth. It is grayish-brown and about ¾ of an inch long with a wing span of about 1 inch. At rest, the moth appears triangular in shape, but when it is disturbed from its favorite resting places, such as ditchbanks and weedy patches, it is most easily recognized by its habit of short, rapid, zigzag flights. At night the moths are attracted in large numbers to lights.

The small, pearly-white, disc-shaped **eggs** are laid singly or overlapping in rows on the undersides of the leaves. These should not be confused with the eggs of the leaf miner, which are cigar-shaped, smaller, and opaque white. The favorite host plants other than sugar beets are lambsquarters and Russian thistle.

The **larvae** on hatching are pale green and about 1/16 of an inch long. They spend most of their time on the undersides of the leaves. They can be seen most readily at this stage by gently shaking the plant and observing the small worms hanging by threads from the leaves. By the time they are fully grown they have changed to an olive-green colour with light and dark longitudinal stripes. At this stage they are 1 to 1½ inches long. The growing larvae will eat continually when the temperature is between 70° and 90° F. They eat holes through the leaves or destroy the leaves leaving only ragged remains of the leaf veins. They develop so quickly that infestations, unnoticed one day, may have destroyed a good part of the leaves by the next day.

When fully grown the larvae drop from the plant and enter the soil. They construct a soil-covered case of silk in which to pupate. The first generation emerges as moths in about one month and the second generation over-winters in the cocoons.

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Moth of the sugar-beet webworm

CONTROL

To control this insect quickly and effectively poisons should be applied before the worms are half-grown. By the time the brown "feathery" appearance of damage can be seen from a distance control is very difficult. Fields should be checked carefully during moth flight for eggs or newly hatched worms, as dense moth flights are not always followed by high population of worms. When the count of worms reaches 1 or 2 per leaf on over one-half of the leaves, control should be applied.

The most effective material to use is toxaphene. When used as a dust it is applied at 2½ to 3 lbs of actual toxaphene per acre; a spray requires 1½ lbs of actual toxaphene per acre.

Beet tops should not be used for forage until at least 30 days after insecticide treatment.

The men who try to do something and fail are infinitely better than those who try to do nothing and succeed.—Lloyd Jones.

Make yourself an honest man, and then you may be sure there is one rascal less in the world.

—Thomas Carlyle

Sugar-Beet Root Aphid

A. M. Harper

Field Crop Insect Section
Science Service Laboratory, Lethbridge, Alberta

The sugar-beet root aphid, commonly called the sugar-beet root louse, is a native of Western Canada. The insect originally spent part of its life cycle on native poplar trees and the remainder on lambsquarters or other native hosts. With the introduction of sugar beets into regions where the aphid occurred, the insect included beets among its summer hosts, and thus has become an insect of considerable economic importance. The insect until recently was thought to be of only local periodic importance, but now it appears possible that this insect may seriously affect the beet industry in Alberta.

The principal summer hosts in Western Canada are sugar beets, table beets, lettuce, and lambsquarters. Other hosts are spinach and Swiss chard.

DAMAGE

This insect sucks the sap from the rootlets and, when in large numbers, will destroy most of the rootlets and severely damage the tap root. A few root aphids will not appreciably change the appearance of beets, but a large population will cause the leaves to become

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Field near Lethbridge, Alberta, that was heavily infested with sugar-beet root aphids. The beets that are infested by this insect will wilt on hot days.

lighter green than those of non-infested beets. If the population increases further and enough sap is removed, the plants will wilt and may be killed. Fairly severe damage may be done before the presence of the root louse is noticed.

When an area is subjected to an early frost, damage is generally more severe on beets that are heavily infested with root aphids than on non-infested beets.

DESCRIPTION

When an infested beet is taken from the ground, a white mold-like substance will be noticed on all the underground portions of the plant and surrounding soil. Crawling around the roots and throughout the earth surrounding them will be found the wingless female aphids, which are oval in shape and pale-yellow-white in color with the rear portion of the body bearing a mass of white waxy filaments. The aphids are about 1/8 of an inch in length and the fore part of the body appears to have been dusted with white powder.

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

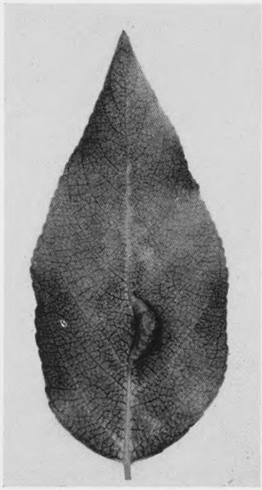
Sugar-beet root aphids feeding on secondary roots of beets

Late in the season winged females may be found.They have two pairs of wings and the entire insect appears to be lightly dusted with white powder. There are white woolly tufts on the rear end of the body. The front portion of the body is black and the rear portion green.

LIFE-HISTORY

The sugar-beet root aphid has an extremely complex life-history. The winter is passed either as a wingless form in the soil or as an egg in a crevice in the bark of a poplar tree. Thus, there are two ways a beet crop may be infested in spring. Winged aphids may fly from poplars to beets, or those that overwinter in the soil may start feeding on the roots of the new crop in spring.

At the time when the leaves of the cottonwood open in the spring a wingless aphid known as a stem mother hatches from each egg. This aphid crawls to the upper side of the poplar leaf and begins to feed by sucking the sap from the leaf. The tissue of the leaf, evidently irritated by the saliva injected during feeding of the aphid, bulges downward at the point of feeding until it forms a pocket containing the aphid. This pocket, or gall, is light green in color and is closed except for a small opening in the upper side of the leaf. In the pocket the aphid develops and gives birth to about 75 young, which have wings when fully developed. Between June and early August the winged aphids fly or are blown in all directions. Many land on beets and establish the colonies that cause the crop damage.



—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Gall on a poplar leaf caused by the sugar-beet root aphid

These colonies, containing only females, are able to increase in numbers very rapidly during the summer because each female produces only females. In late summer and early fall the wingless aphids on the beets produce large numbers of winged forms, which fly to the poplars. In protected places on the bark they give birth to several small, yellow, wingless aphids that are either male or female. After mating each of the females deposits one white egg in a crevice in the bark of a tree or under the bark of dead branches, where it remains during the winter

CONTROL

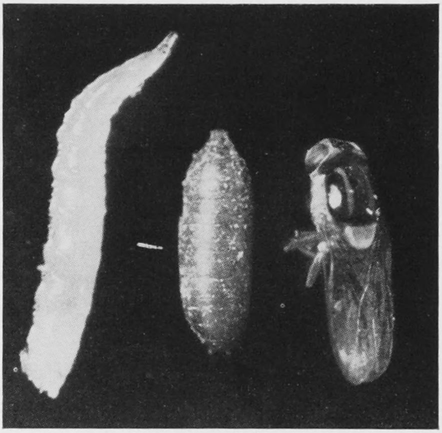
Investigations have shown that rotation is not effective in controlling the sugar-beet root aphid. The number of aphids present when beets follow beets is about the same as when beets follow other crops.

Chemical Control. At present there is no satisfactory chemical control for the sugar-beet root aphid, but tests being conducted

at present indicate that some of the newer insecticides may give a measure of control.

Natural Control. There are several predators that aid in controlling the sugar-beet root aphid. These include fly larvae, lady bird beetles, ants, and other insects.

It is quite likely that the use of an insecticide will be limited because of the beneficial insects it will destroy. At present it appears that the beneficial insects are preventing the root aphid from becoming a more serious problem.



—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Larva, pupa, and adult chloropid fly. The larva destroys sugar-beet root aphids

Cultural Control. From available information the best method of reducing damage by this insect is to plant early, to irrigate early and frequently, and to keep soil fertility at a high level.

The nation that has the schools has the future.

—Bismark

My share of the work of the world may be limited, but it is work makes it precious. Darwin could work only half an hour at a time; yet in many diligent half-hours he laid anew the foundations of philosophy. Green, the historian, tells us that the world is moved not only by the mighty shoves of the heroes, but also by the aggregate of the tiny pushes of each honest worker.

—Helen Keller

Sugar-Beet Root Maggot

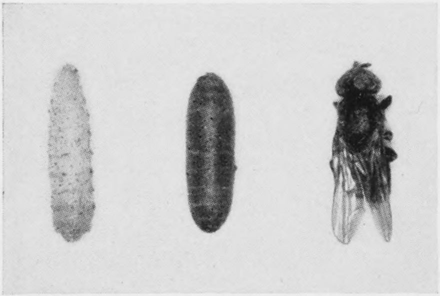
A. M. Harper

Field Crop Insect Section
Science Service Laboratory, Lethbridge, Alberta

In most years the sugar-beet root maggot causes minor damage and generally is present only in the sandy soil areas. From 1934 to 1936 and again in 1955 this insect caused severe damage in light soils of the Taber-Cranford irrigation district in Alberta. In Manitoba it has been present for many years but only recently has it become a serious pest. In 1954 about 100 acres of sugar beets were affected, some fields sustaining losses up to 50 per cent. In 1955 damage in Manitoba was negligible. In the last few years severe outbreaks of this insect also occurred in North Dakota, Idaho, and Colorado.

DAMAGE

The maggot feeds on the beet root, causing "bleeding" and wilting, which result in a reduction in sugar content and yield. Severe infestations may reduce yield by 3 to 8 tons per acre. The severest injury occurs during July and early August where fields are dry and maggots have gone deep into the ground. Under these conditions they feed near the tip of the root, causing the beet to wilt and die. Whenever a maggot feeds, an opening is made that permits root-rotting organisms to enter the beet and cause further damage to the crop.



—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Larva, pupa, and adult sugar-beet root maggot

DESCRIPTION

The **eggs** of the sugar-beet root maggot are white, slender, and slightly curved.

The **maggots** (larvae) are white, without legs, eyes, or distinct head. They are largest at the rear and taper like a cone toward the front. They vary from ¼ to ½ inch in length.

The **pupal stage** is spent in a brown pupal case, which is oval and slightly shorter than the maggot.

The **fly** (adult) is black and about ¼ of an inch in length. It has transparent wings, which have a small dark area on the front margins.

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Beet field near Taber, Alberta, that was severely damaged by the sugar-beet root maggot

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Sugar-beets that were damaged by sugar-beet root maggots early in the season. These beets put out numerous secondary roots

LIFE-HISTORY

The sugar-beet root maggot overwinters as a mature larva at a depth of 8 to 14 inches in the soil. In early spring it moves to 3 to 4 inches below the soil surface and pupates.

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Sugar-beet root maggots in the soil around a damaged sugar beet

In Alberta the fly emerges from the pupal case about thinning time and deposits its eggs in the soil around a sugar beet or other host plant. The maggots hatch from these eggs, crawl below the surface of the soil, and feed on the root of the beet. As the soil warms or dries, the maggots move deeper.

There is generally only one main brood a season.

CONTROL

Cultural Control. Once a field is infested the sugar-beet root maggot cannot be controlled.

Early seeding in a well prepared and well fertilized seed bed, followed by an adequate irrigation program, will reduce losses.

Crop rotation and weed control along field margins and ditches will also help to keep this pest in check. **Beets should not follow beets** where root maggots have been found.

Chemical Control. The newer insecticides have not been tested on the sugar-beet root maggot in Canada. In North Dakota, however, satisfactory control has been obtained with any of the following insecticides:

1 to 2 lbs of actual heptachlor per acre
1 to 2 lbs of actual aldrin per acre
1 to 2 lbs of actual dieldrin per acre

The chemical should be mixed with the fertilizer and applied at the time of seeding.

Wireworms

C. E. Lilly

Field Crop Insect Section

Science Service Laboratory, Lethbridge, Alberta

Mr. Lilly is in charge of wireworm studies in irrigated areas of Alberta. He has obtained a B.Sc. degree in Agriculture and an M.Sc. degree in Entomology from the University of Alberta. Mr. Lilly worked for several years on the insect pests and pollinators of forage crops in Alberta.

There are over 100 different species of wireworms found in the Prairie Provinces. Fortunately for the farmer only 4 or 5 of these are ever found in fields in large enough numbers to cause serious damage to crops. They will attack most crops, although potatoes, corn, onions, lettuce, beans, tomatoes, and sugar beets are particularly susceptible to injury.

DESCRIPTION

The four stages in the life-history of any wireworm are the egg, the larva, the pupa, and the adult.

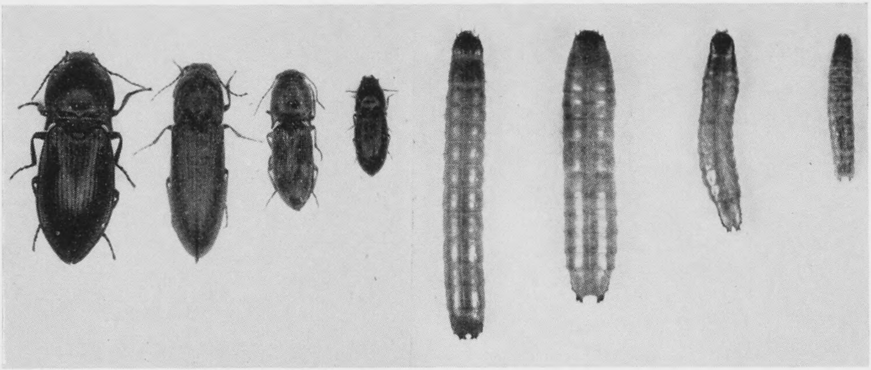
The **eggs** are very tiny and are pearly white in color. They look like little white specks in the soil, and it is doubtful whether the farmer will ever see them in the field.

The wireworms, or **larvae,** are hard-bodied, slow-moving "worms," varying from yellowish-white to straw color. They do not curl up when disturbed as do cutworms. Fully developed larvae vary from ⅜ to 1 inch in length, and each has a flattened, notched "tail." This helps to distinguish them from other worms that are often found in the soil. This is the stage of the insect that causes damage to crops.

The **pupae** are soft, white, and delicate. They are not often seen in the field, as they are usually from 3 to 5 inches deep. This is an inactive stage, which does no damage to the crops.

The **adults** of wireworms are called "click" beetles because they spring into the air with a clicking sound when placed on their backs. **No other beetles do this.**

The four different wireworm beetles that the farmer might expect to see in sugar-beet fields range from about 1/4 to 1/2 inch in size and vary in color from light brown to black.



—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Four "Click" beetles found in beet fields: adults of the prairie grain wireworm, sugar-beet wireworm, flat wireworm, lesser grain and grass wireworm (1½ times normal size)

Four wireworms that damage sugar beets: sugar-beet wireworm, prairie grain wireworm, flat wireworm, lesser grain wireworm, flat wireworm, lesser grain and grass wireworm (twice normal size)

LIFE-HISTORY

Wireworms differ from most of our common pests in that they take from 1 to 10 or more years to develop from egg to adult. Although the life-histories of the various species of wireworms differ, in general all of them develop as follows:

Each year, in the latter part of July or in early August, some of the oldest larvae, having spent all their time in the soil, come within 3 to 5 inches of the surface of the soil and there change to pupae.

In 3 or 4 weeks the pupae change to beetles, which remain in the soil overwinter. They appear on the surface as soon as the soil begins to warm up in the spring but do not lay eggs until May or June. The eggs, which are laid in moist soil, soon hatch and the tiny larvae begin their long period of development.

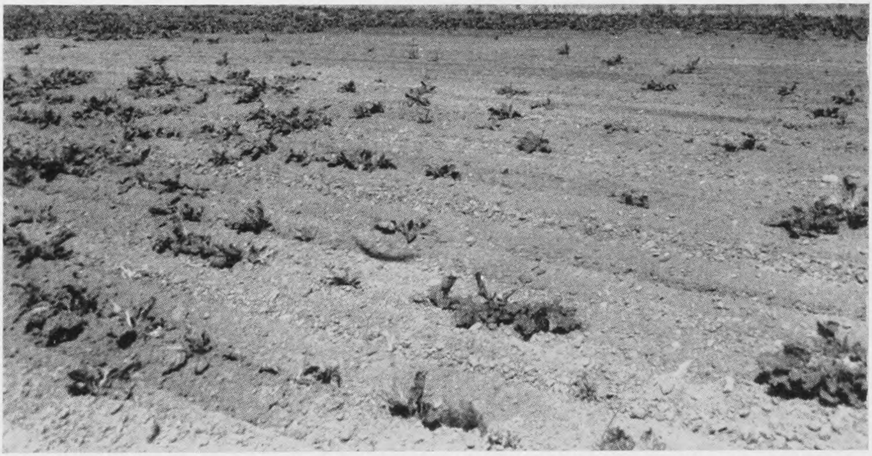
Early each spring wireworms move near to the surface to feed and as the top layer heats up and dries out they go deeper in the soil. In irrigated lands they usually feed for a much longer period of time than in dry land. In cooler, fall weather, however, they are found deeper in the soil, where they overwinter.

DISTRIBUTION

Although it is probable that wireworms occur in every field, damaging populations are more commonly found in light, well drained soils.

When beets are grown under irrigation, damage is generally confined to knolis and ridges, where it is difficult to apply water.

Heavy soils are almost entirely free of most wireworms, although the sugar-beet wireworm prefers heavier soil that is fairly alkaline. Fortunately this pest is not yet widespread throughout the sugar-beet area of Alberta but is definitely one to be watched closely.



—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Sugar-beet field near Turin, Alberta, that was seriously infested by wireworms

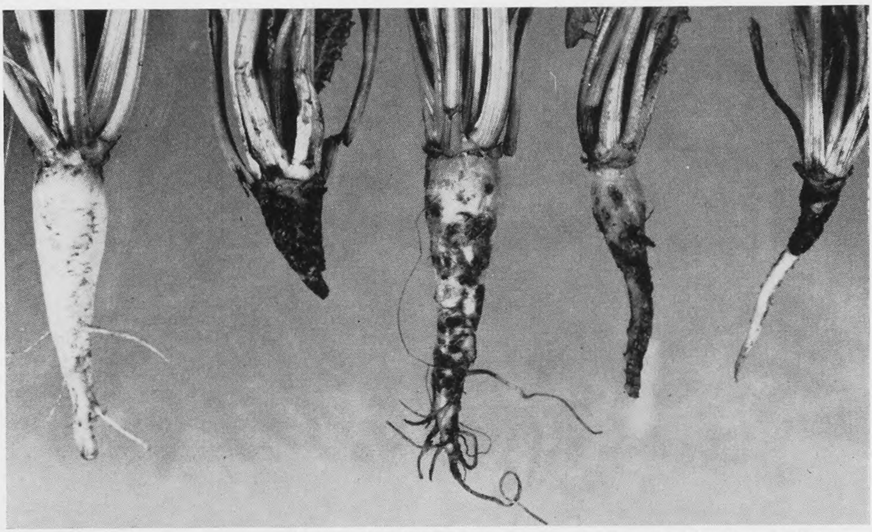
DAMAGE

The type of damage depends on the development of the crops. Soon after seeding, wireworms move along the rows eating out the contents of each seed. Later they feed on the young tap roots, shredding them and causing the plants to wilt and die in hot, dry weather. If the weather is cool and moist, the plants may recover but in many plants tap root development is arrested and the plants send out numerous secondary or fibrous roots. Still later in the season wireworms will feed on the enlarged roots, making shallow wounds. The plants at this stage will not be killed, but some "bleeding" will occur and the openings will provide entrance for root-rotting organisms. When the wireworms cease feeding these older plants recover to a large extent.

The point at which feeding has occurred will generally be dark-colored and moist. The soil around the feeding area will be unusually moist.

Sugar beets can stand considerable thinning without serious loss in yield. However, if thinning results in patchy areas in the field, there will be a loss in yield proportional to the loss in plants. Even in patchy fields one should make sure that the loss is attributable to wireworms, because high alkalinity, poor germination, and the sugar-beet root maggot also cause patchiness. Dig around a few of the remaining beets to determine whether there are signs of feeding and, if there are, whether the insects themselves are still present. Injury to the beet roots by wireworms is so similar to that caused by the sugar-beet root maggot that unless one finds the pest causing the damage it is difficult to determine which is involved.

It is very probable that, with the use of decorticated seed and mechanical thinners, damage by wireworms will become more important. It is also probable that, as the continued use of water changes the alkalinity and other characteristics of the soil in the irrigated areas, wireworms that do not cause much trouble at present may become problems in the future.



—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Comparison of a healthy sugar beet with four damaged by wireworms

CONTROL

Cultural Control. Where wireworms are present in such small numbers that it is not profitable to use insecticides, good farming practices will usually keep populations from building up.

Frequent shallow cultivation of summer-fallow during June and July will starve many of the very young wireworms and will kill some of the pupae by crushing them or causing them to dry up.

When sugar beets are grown, the use of a recommended fertilizer and adequate amounts of irrigation water to speed up the growth of the plants will reduce damage.

Chemical Control. Where it is evident from previous crop damage or from spring soil-sampling that a large wireworm population is present in a field, the use of insecticides is profitable. These can be applied as seed or soil treatments.

Seed Treatment. Latest recommendations are 4 ozs. of actual lindane, heptachlor, or aldrin per 100 lbs of seed. Do not apply too much insecticide as it may reduce germination.

Sugar-beet seed is usually treated with a fungicide; therefore only the insecticide should be added. Check with representatives of the sugar company before treating your seed for wireworms.

Treating grain in a rotation will not necessarily prevent wireworm damage to beets the following year.

Soil Treatments. Soil treatments, while much more expensive, will undoubtedly give better control of wireworms for a much longer period of time. Aldrin or heptachlor at 5 lbs actual per acre or chlordane at 10 lbs actual per acre may be applied broadcast as dusts or sprays and immediately worked into the soil to a depth of 3 to 4 inches prior to seeding.

The character and qualifications of the leader are reflected in the men he selects, develops and gathers around him. Show me the leader and I will know his men. Show me the men and I will know their leader. Therefore, to have loyal, efficient employees —be a loyal efficient employer.

—Arthur W. Newcomb

The man who has not anything to boast of but his illustrious ancestors is like a potato — the only good belonging to him is underground.

—Sir Thomas Overbury

Flea Beetles

G. E. Swailes and A. M. Harper

Field Crop Insect Section
Science Service Laboratory, Lethbridge, Alberta

Flea beetles are economically important pests of a wide variety of plants. The most serious damage occurs when the seedlings first appear above ground. Entire sugar-beet fields may be destroyed before young plants can become established.

DESCRIPTION

Several species of flea beetles may feed on beets, but the one most commonly found is a shiny black beetle about 1/16 to 1/8 of an inch long. Flea beetles, as their name suggests, are very active and jump like fleas when disturbed. They are most often seen on beet leaves when the weather is warm and bright.

DAMAGE

Most damage occurs early in the season when the beets are small and easily injured. This is most pronounced about the time the seed leaves emerge. The leaves may be eaten down to the crown. and the plants die as a result of large numbers of beetles feeding on single plants.

—Photo R. D. Bird

Sugar-beet leaf seriously infested with flea beetles. Note the flea beetle damage and the small black flea beetles

When feeding, the flea beetle makes small holes in the foliage. Instead of eating through the leaf, it leaves a thin layer, which appears as a white patch. These patches drop out, leaving small holes in the leaves and producing what is often called a "shot hole" effect. If enough tissue is destroyed the leaves turn brown, wither, and sometimes drop.

LIFE-HISTORY

The life-histories of the various species of flea beetles are quite similar.

In spring, the very small, white **eggs** are laid in the ground around the beet plant at a depth of ½ to ¾ inch.

The **larvae** are white with dark heads. They feed mainly on the fine roots and root hairs and sometimes on the surface of the main root. The feeding of the larvae seldom causes serious damage.

The larval period lasts for 3 to 4 weeks and is followed by the **pupal stage** which lasts 2 weeks. This is an inactive stage of the insect.

Flea beetles overwinter as adults under leaves and other debris in or near the beet fields. They emerge during the first warm days in spring and feed on mustard, lambsquarters, and other host plants. After a short period of feeding they mate and the females lay eggs in the soil.

CONTROL

Cultural Control. Clean cultivation is an important practice where flea beetles are abundant because weeds along headlands and in ditches serve as the breeding and overwintering place for many of them.

Chemical Control. Flea beetles can be readily controlled by any of the following:

⅓ to 1 lb of actual DDT per acre
½ to 1 lb of actual aldrin per acre
1 to 2 lb of actual chlordane per acre
1 to 2 lb of actual toxaphene per acre

Sprays or dusts should be used when beetles first appear and should be well distributed over the foliage. Flea beetles readily move from weeds to beets and from one field to another. It is necessary to maintain constant vigilance and repeat the treatment at 10-day intervals as long as flea beetles are present.

Spinach Carrion Beetle

A. M. Harper and G. E. Swailes
Field Crop Insect Section
Science Service Laboratory, Lethbridge, Alberta

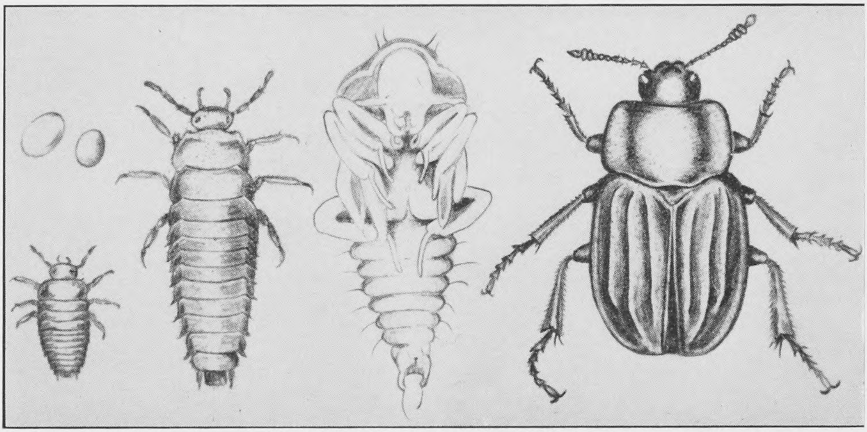
The spinach carrion beetle is one of the pests that cause damage to sugar beets in localized areas of many fields every year.

DESCRIPTION

The **egg** is oval and creamy white, and its surface is polished and glistening. It is about 1/16 inch in size and is found in the soil.

The **larva** is shiny black and varies from ¼ to ½ inch in length.

The **pupa** is entirely white and soft and is about ½ inch long.



—Drawn by G. Hirst (reference Jr. Econ. Ent, 10:97. 1917)

Spinach carrion beetle eggs, small larva, large larva, pupa and adult (enlarged)

LIFE-HISTORY

The adult overwinters in the soil along field margins, ditch-banks, and roadsides. In May and early June the mated female lays her eggs in the soil. The eggs may be laid as deep as 2 inches.

The larvae are easily disturbed and, when frightened, tumble to the ground and crawl rapidly under clods of soil. They remain in hiding in the soil in the daytime, preferring to feed at night, but when they are abundant in a field some may be found during the day.

When full-grown they burrow into the soil to a depth of 1 to 2 inches and construct oval cells in which to pupate.

The adults emerge from the soil in 2 to 4 weeks and commence feeding on the beets.

DAMAGE

Both the larvae and adult beetles eat the beet leaves. The injury takes place mainly in May while the plants are small. The injury may be scattered throughout the field, but more often occurs around the edges, where the plants are completely eaten. The insects generally migrate in from adjoining fields where some favorite food plant such as lambsquarters or pigweed occurs.

CONTROL

Cultural Control. As these insects commonly migrate into beet fields from weedy places nearby, it is advisable to keep the vicinity of beet fields free of such weeds as lambsquarter and red root pigweed to reduce damage by this pest.

Chemical Control. The larvae and adults of this beetle are readily killed by DDT dust or spray at 1 lb of actual DDT per acre.

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Field cages used for studying sugar beet insects

Cutworms

L. A. Jacobson

Field Crop Insect Section
Science Service Laboratory, Lethbridge, Alberta

Mr. Jacobson is a graduate in Science of the University of Alberta and in Entomology of Montana State College. He has worked on many entomological problems in Alberta and is probably best known for his work on the Say stink bug and the pale western cutworm. Mr. Jacobson is in charge of research on cutworms in Alberta.

Cutworms are common pests of field and garden crops. They are the larvae of moths, the so-called "millers" that are abundant around lights during the summer. The pale western cutworm is mostly a pest of grains in the open prairie regions. In park belt and irrigated areas the red-backed cutworm attacks a variety of crops including sugar beets. Several kinds of cutworms are found in gardens, where they feed on vegetables, fruits, and flowers.

DESCRIPTION

Cutworms are fleshy, soft-bodied worms that curl up when disturbed. They usually feed at night, when they cut off plants at or near the soil surface. When full-grown, they are about 1½ to 2 inches long, the upper half of the body is generally darker than the under half, and the back and sides may be striped or otherwise marked.

—Photo Field Crops Insect Lab., Saskatoon, Sask.

Red-backed cutworms

LIFE-HISTORY

Most cutworms have one generation a year but the life-cycle varies among the species that occur in the prairies. The moths lay small, pearly white eggs in loose uncrusted soil during late summer and fall. Hatching occurs the following spring and the young cutworms begin to feed as soon as green growth is available and continue feeding until mid-summer, when they become full-grown. At

the end of this feeding period the larvae change into brown, inactive pupae, which remain in the soil for several weeks before the moths emerge.

CONTROL

The method of control depends upon the species of cutworm, the crop attacked, and the area infested. In gardens and small fields the application of poisoned bait is effective when applied properly and at the correct time. When fields are large or when damage is extensive, efficient control can be obtained by spraying the soil and plants with a solution of one of the new insecticides.

Chemical Control. POISONED BRAN BAIT is an effective method of controlling cutworms and consists of the following ingredients:

	Garden Quantity	Field Quantity
Bran	1 gal	25 lbs
Chlordane (40% emulsion)	2 tbsps.	8 oz.
or		
Aldrin (20% emulsion)	2 tbsps.	8 oz.
Water (to moisten)	1½-2 pts.	2½ gals.

Combine the water and liquid poison together and then stir into the bran and continue mixing until the bait is uniformly moistened and free of lumps.

The bait should be scattered evenly and uniformly over the garden or infested field about dusk on warm, calm days. The temperature should be 70° F. or higher.

SPRAYING with insecticides in solution is a quick and efficient method of cutworm control in larger fields. A weed sprayer that will apply not less than 10 gallons of solution per acre to the soil can be used. Either of the following insecticides is effective for cutworm control when combined with water and sprayed on the vegetation and soil surface:

1½ lbs of actual chlordane per acre

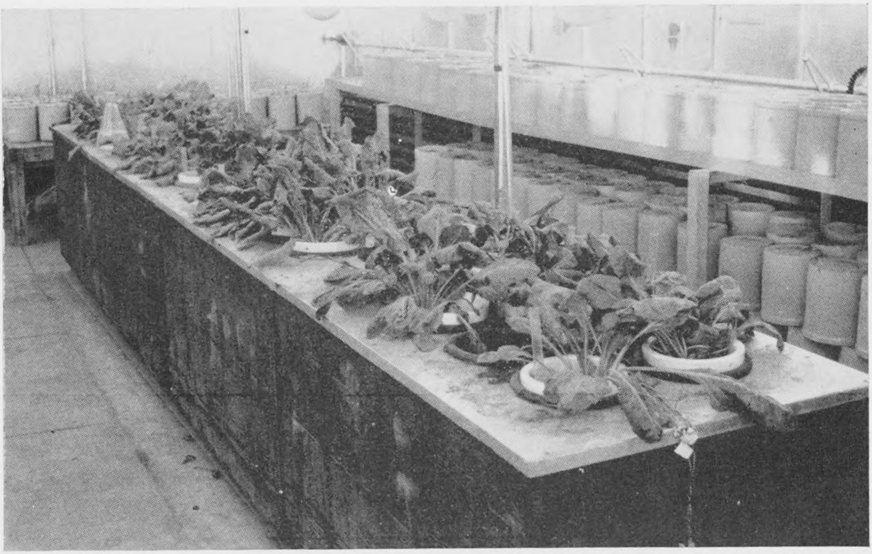
¾ lb of actual dieldrin per acre

Cultural Control. Infestations can be reduced or prevented by cultural methods. If fields are cultivated early in the spring and left bare of weeds and other growth for at least two weeks, the young larvae may be starved. Infestations of the pale western and red-backed cutworms can be minimized by cultivation of summerfallow fields that are to be cropped the following year. Weeds should be

destroyed in late July by cultivation and the fields left undisturbed and crusted until early September. In irrigated areas where the red-backed cutworm is a hazard, weeds appearing on fallow in August should be destroyed, as this cutworm lays its eggs in soil in areas bearing a weed growth.

Other Controls. This includes the hand-picking of cutworms in small gardens and the setting of collars of tin or heavy paper around transplants. The collars should extend about 2 inches above and below the soil surface.

I don't think much of a man who is not
wiser today than he was yesterday.
—Abraham Lincoln



—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Soil temperature tanks at the Science Service Laboratory, Lethbridge, Alberta. These are used for studying the influence of soil temperature on insects and diseases

Spinach Leaf Miner

A. M. Harper and G. E. Swailes

Field Crop Insect Section
Science Service Laboratory, Lethbridge, Alberta

The spinach leaf miner is widely distributed over the United States and Canada. Although these insects are often numerous in Western Canada, damage has never been considered severe because the damaged sugar beets put out new growth and continue their development without serious setback.

DAMAGE

The newly hatched larva makes a hole in the outer covering of a leaf and feeds on the inner tissue. As the maggot eats out this green tissue a white spot is left in the leaf, thread-like at first but later appearing as a large irregular-shaped blotch or blister. The leaves droop and wilt in warm weather more rapidly than do the leaves of unaffected plants.

—Photo R. D. Bird

Beet leaf damaged by spinach leaf miner

DESCRIPTION

The **eggs** are white, elongate, and about 1/28 inch in length. They are deposited singly or in groups or 2 to 6 on the undersides of leaves of host plants. **They should not be confused with the flat scale-like eggs of the sugar-beet webworm,** which may be present at the same time.

The **larva**, which is found inside the leaf, is white or yellowish. As it is almost transparent, the green food it consumes may be seen within the body. This maggot is headless and legless, and it tapers from front to back.

The **pupa**, or resting stage of the insect, is spent in a puparium, a brown covering made of the last larval skin of the maggot. The puparium is oval, brown, and about ⅕ inch long, and may be found in the ground beneath infested beets.

The **adult** leaf miner is a grey fly, its body covered with long stiff bristles and its abdomen bent downward or curved under. It is about ¼ inch long and looks very much like a house fly.

LIFE-HISTORY

The leaf miner passes the winter as a pupa in the soil beneath its host plant.

In spring, about the end of May, the adult fly breaks open the puparium and crawls to the surface of the ground. The males and females mate, and the females place their eggs on the undersides of the leaves of beets or lambsquarters.

When the egg hatches, the small maggot at once eats a hole through the surface of the leaf and feeds within the leaf between the upper and lower surfaces.

When the maggot is fully grown it emerges from the leaf and drops to the ground. It crawls beneath the surface to a depth of 2 to 3 inches, where it changes to a pupa.

CONTROL

Cultural Control. Maintaining high soil fertility and supplying the beets with adequate moisture enables the plants to resist the injurious effects of infestation.

Destroying lambsquarters and other weeds in fields and ditches helps prevent this pest from becoming established on its weed hosts.

Chemical Control. It is very difficult to control this pest by insecticides because the larva lives in the leaf tissue. Control can be obtained if plants are sprayed, as soon as eggs appear, with either of the following:

6 - 8 ozs. of actual aldrin per acre
1 lb of actual chlordane per acre

Natural Control. Parasites aid considerably in keeping this pest under control. In some areas counts have shown that 60 - 80% of the maggots may be parasitized. This is believed to be one reason why there are so few of these insects in the later broods each season.

False Chinch Bug

A. M. Harper and G. E. Swailes

Field Crop Insect Section

Science Service Laboratory, Lethbridge, Alberta

False chinch bugs may appear suddenly in large numbers in beets or other cultivated crops and destroy the entire crop in a few days if action is not taken against them. This insect has appeared in beet fields in Alberta but has caused severe damage in only a few cases.

DAMAGE

This insect has sucking mouth parts and feeds by puncturing the leaf and sucking the sap from the plant. Infested leaves wilt and become ragged and full of irregular holes.

DESCRIPTION

The **eggs,** tiny, slender, and whitish, are deposited by the females in small batches.

The **nymph** resembles the adult but is dark in color with darker stripes and markings on the anterior part of the body. The nymph does not have wings.

The **adults** are very small grayish-brown bugs about 1/6 inch long and 1/20 inch wide. The wings are transparent and lie flat and overlapping.

LIFE-HISTORY

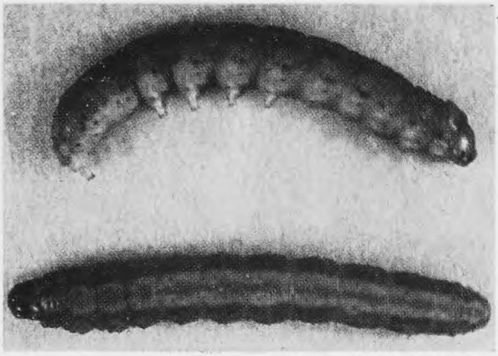
The winter is passed as either an egg or a young nymph. After reaching maturity in the spring the insects mate and females deposit their eggs in cracks in the soil. After 4 days the eggs hatch into tiny wingless nymphs, which grow rapidly and reach maturity after 5 successive moults covering a period of about 30 days. There are several broods during the summer with numbers varying according to weather and locality.

CONTROL

Cultural Control. Keeping headlands and ditches free of weeds will reduce the breeding places for these insects.

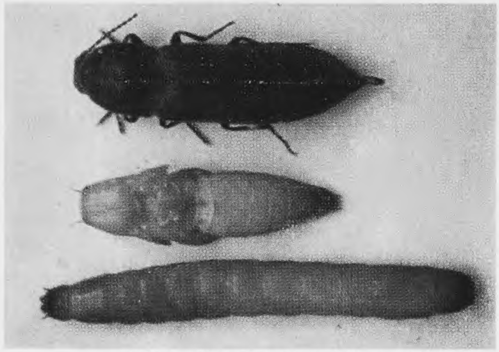
Chemical Control. Thorough spraying of infested crops with 1 lb of DDT per acre will control this pest.

If these insects are abundant on weed hosts it may be advisable to control them to prevent any movement into the crop.



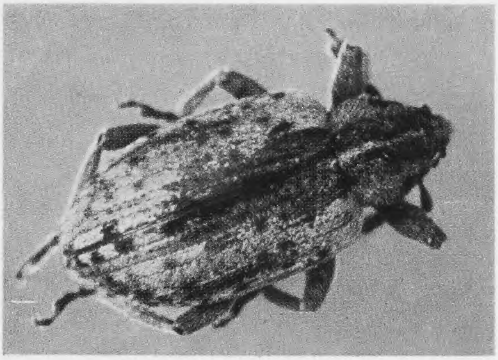
—Photo R. D. Bird

Red-backed cutworm larvae



—Photo Section, Can. Dept. Agric.,
Lethbridge, Alberta

Wireworm, adult, pupa, and larva

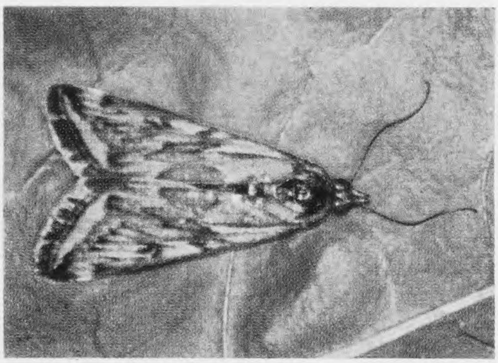


—Photo Section, Can. Dept. Agric.,
Lethbridge, Alberta

Alfalfa weevil adult

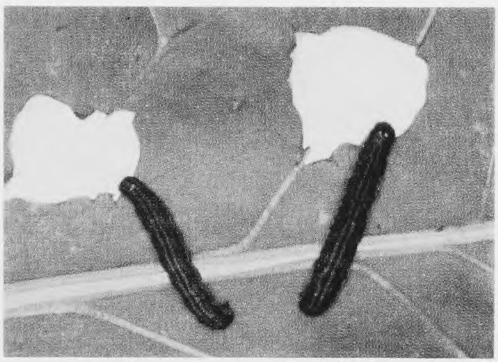
—Photo Section, Can. Dept. Agric.,
Lethbridge, Alberta

Sugar-beet root aphids



—Photo Section, Can. Dept. Agric.,
Lethbridge, Alberta

Sugar-beet webworm moth



—Photo Section, Can. Dept. Agric.,
Lethbridge, Alberta

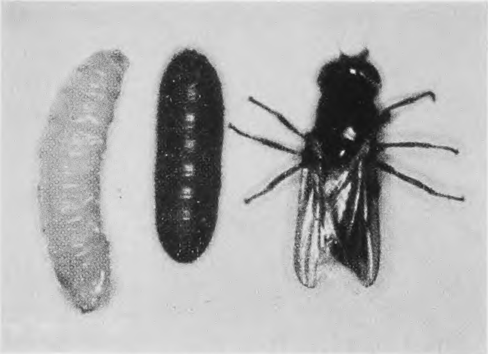
Sugar-beet webworm larvae

—Photo Section, Can. Dept. Agric.,
Lethbridge, Alberta

Wireworm damage and larvae

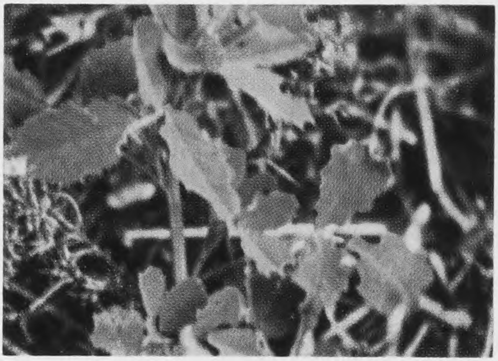
—Photo Section, Can. Dept. Agric.,
Lethbridge, Alberta

Sugar-beet root maggot damage and larvae



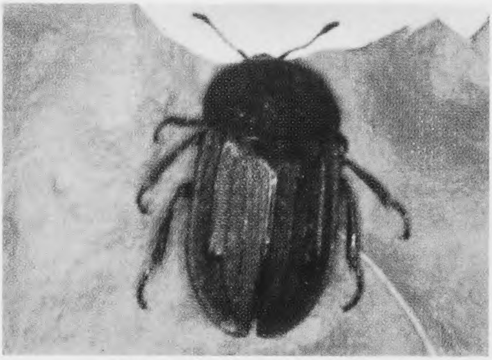
—Photo Section, Can. Dept. Agric.,
Lethbridge, Alberta

Sugar-beet root maggot larva, pupa, and adult



—Photo R. D. Bird

Leaves notched by the sweetclover weevil



—Photo Section, Can. Dept. Agric.,
Lethbridge, Alberta

Spinach carrion beetle adult

—Photo R. D. Bird

Blister beetle adult

Blister Beetles

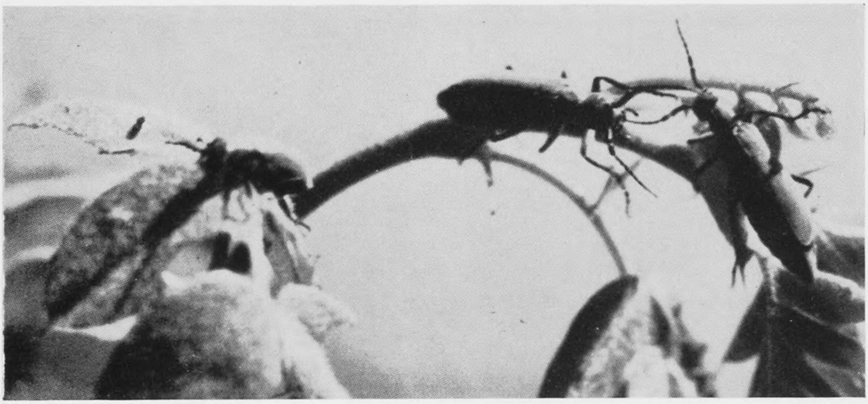
A. M. Harper and G. E. Swailes

Field Crop Insect Section

Science Service Laboratory, Lethbridge, Alberta

There are numerous species of blister beetles in the sugar-beet-growing areas of Western Canada. Usually these are not important as pests but are regarded as beneficial, for in the larval stage they aid considerably in destroying grasshopper and cricket eggs. At various times, particularly during grasshopper outbreaks, adult blister beetles may serious damage beets.

Blister beetles are general feeders, each species having certain plants it prefers. The sugar beet is one of the favorite foods of the spotted blister beetle.



—Photo R. D. Bird

Adult blister beetles

DAMAGE

Blister beetles may move into beet fields in swarms and severely damage plants or strip them of their leaves in a very short time. The beetles bite pieces out of the foliage, giving the plants a ragged appearance.

The actual damage to the crop depends on the stage of growth of the plants at the time of attack. If the plants are damaged when they are near maturity, the yield is lessened but the crop is not a total loss. Unless sugar beets are suffering from lack of moisture at the time of defoliation, they put forth new leaves and continue their growth but the defoliation decreases tonnage and sugar content.

DESCRIPTION

The **eggs** are yellow in color, elongate, and more or less cylindrical and are found in the soil.

As the **larva** develops it changes considerably in form and appearence. When hatched it is active and has relatively long legs, which become shorter in each succeeding stage. The last larval stage is yellow in color, tough-skinned, and about ½ inch in length, with mouth parts and legs greatly reduced.

The **pupa** is white to yellowish-white in color and is found in the ground. This insect does not have a cocoon.

The **adults** will generally average ½ to ¾ of an inch in length. The body is slender and soft, and the head is broad and quite distinct from the rest of the body. The different species vary in color from metallic black or bluish purple to gray or brown, and some have spots or stripes. The spotted blister beetle, which is the one commonly found on beets, is gray with black spots.

LIFE-HISTORY

The female beetle deposits her eggs in a little pocket dug in the ground during late summer.

The small active larvae that hatch in 2 to 3 weeks feed mostly on grasshopper and cricket eggs.

In the spring these larvae transform into pupae and in June the adult beetles emerge from the soil. Normally there is only one generation a year in Western Canada.

CONTROL

Chemical Control. Any of the following insecticides gives good control when used as recommended:

1 ℔ actual DDT per acre
1 ℔ actual chlordane per acre
½ ℔ actual rotenone per acre
2 ℔s actual toxaphene per acre

When blister beetles attack, control measures must be prompt and thorough. In years of grasshopper outbreak growers are advised to watch for the attacks of these beetles.

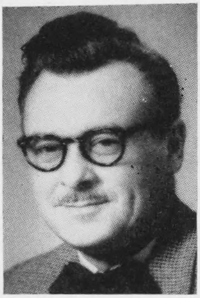
He is not idle who does nothing, but he is idle who might be better employed.—Socrates.

Grasshoppers

D. S. Smith

Field Crop Insect Section

Science Service Laboratory, Lethbridge, Alberta



Mr. Smith completed his B.Sc. in Chemistry and Zoology at the University of Manitoba and his M.Sc., in Entomology at Minnesota, and expects to complete his Ph.D. in Entomology at the same University in 1956. Mr. Smith was a member of the Dominion Entomological Laboratory, Manitoba, in 1936-41 and 1945-49, where he conducted research on grasshopper ecology. He is now in charge of grasshopper research at the Lethbridge Science Service Laboratory.

Grasshoppers are common pests of cultivated crops, and when they are very abundant there are few crops that will escape damage. Most serious damage occurs to dry-land grain crops because it is here and on roadsides that grasshoppers lay eggs. However, crops that are green in the early fall, such as sugar beets, will attract grasshoppers from fields of ripening grain.

Three species of grasshoppers cause the most damage. Two of them, the clear-winged grasshopper and the two-striped grasshopper, lay their eggs principally in sod or roadsides and pastures and along ditchbanks. The third and most destructive species, the lesser migratory grasshopper, lays its eggs principally throughout cropped fields and waste land. All of them avoid laying in land that is completely bare, such as summer-fallow, and in moist soil, such as is often found in irrigated fields.

DESCRIPTION AND LIFE-HISTORY

The eggs are laid from late summer until freeze-up and hatch the following spring. The eggs lie under ½ inch of soil or more and are affected very little by the winter weather but may be damaged by a number of soil insects that feed on them. The eggs hatch after early May; warm and dry spring weather favors an early hatch. Generally the earlier the hatch the more damage the grasshoppers do, because the plants are smaller and less able to withstand the insects' attack. During spring and early summer these young grasshoppers go through a series of changes. After each change they are bigger and more like the full-grown grasshopper. By mid-summer and early fall they become adult grasshoppers with wings. Shortly after this they are ready to lay eggs. In the late fall, after egg laying,

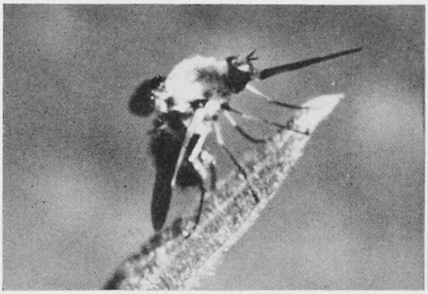
they die. There are a few kinds of grasshoppers that will live through the winter as partly or fully grown insects, but these do not damage crops.

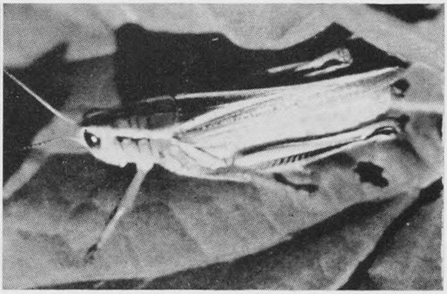
DAMAGE

Early spring damage is not common in irrigated fields because grasshoppers generally do not lay eggs in these fields. 'Hoppers may move from adjacent roadsides or dry-land fields into seedling crops such as alfalfa, corn, beets, and turnips, and cause extensive destruction. Most damage will occur later in the summer when grain fields are ripening and the insects are looking for green food.

CONTROL

Chemical Control. The young grasshoppers are the easiest to control, requiring less poison because they are smaller and often crowded together. Roadside populations adjacent to cropped fields are most easily controlled at this stage and every effort should be made to control them before they have a chance to spread into the fields. Control later in the year presents added difficulties because of the greater amount of foliage to be covered with poison, the larger size of the grasshoppers, the ability of the adult grasshoppers to fly, and the possibility of damage to the crops by the equipment used for control.





—Photos R. D. Bird

The larval stage of this beefly destroys grasshopper eggs

Two-striped grasshopper

The common method of control for grasshoppers is the application of a poison spray by any suitable type of spraying equipment. Sprays have almost completely replaced baits because they are easier to prepare and apply and much more efficient in killing grasshoppers.

Various poisons can be used and the following rates of application will serve as a guide:

½ lb of actual chlordane per acre
3 ozs. of actual aldrin per acre
1 oz. of actual dieldrin per acre
1 lb of actual toxaphene per acre

Preferably, however, **read** and **follow the directions** on the label on the material to be used. Also, read the section of this pamphlet entitled "Insecticides for Crop Protection."

Do not use plants that have been sprayed as food for livestock or human consumption within 30 days of spraying.

Natural Control. Generally the population of grasshoppers is controlled by several natural factors. Weather is one very important factor. There are also a number of other insects that prey on the grasshopper. Flesh flies parasitize the nymphal and adult stages and cause considerable reduction in numbers, but probably the greatest reduction results from the activities of those insects feeding on grasshopper eggs, such as the young stages of bee-flies and various beetles. At times, however, all these factors fail to keep the numbers of grasshoppers down, and then control with poisons becomes necessary.

Science can only prosper where there is a general understanding that the last word has never been said on any subject: there must be no dogma, for that would be an obstacle rather than a help to enquiring minds.

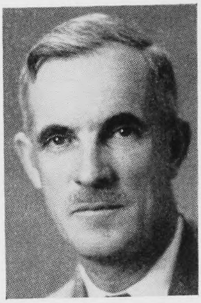
—John R. Baker

The secret in happiness is not in doing what one likes but in liking what one has to do.

—James M. Barrie

The Sweetclover Weevil

R. D. Bird, J. S. Kelleher and W. R. Allen
Entomology Laboratory, Brandon, Manitoba



Dr. Bird is Officer-in-charge of the Field Crop Insect Laboratory at Brandon, Manitoba. He received his B.S.A. and M.Sc. degrees from the University of Manitoba and his Ph.D. in Zoology from the University of Illinois. Dr. Bird has contributed much to our knowledge of insects in Manitoba and is very interested in animal ecology. He is an amateur photographer and is well known for his photographs of insects and wildlife. Some of his photographs appear in this publication.

The sweetclover weevil is a European insect, which first reached injurious numbers in Manitoba in 1939 and in Alberta in 1946. It is now an established pest of sweet clover in the Prairie Provinces. All varieties are attacked. Red, white, and alsike clovers are immune. Alfalfa is attacked only when it is grown adjacent to an infested field of sweet clover and after the sweet clover has been destroyed by cultivation.

DESCRIPTION

The **eggs** are round and about the size of a sand grain. They are dropped on the surface of the ground as the adult feeds. At first they are white but in 24 hours they turn black.

The **larvae** are white with a brown head and 6 short legs. They are rather inactive and rest in a partly curled position. Fully mature larvae are nearly ¼ inch long.

The **pupae** are also white. They are found in earthern cells.

The **adult** is a grey beetle with a short snout. It is about 3/16 inch long.

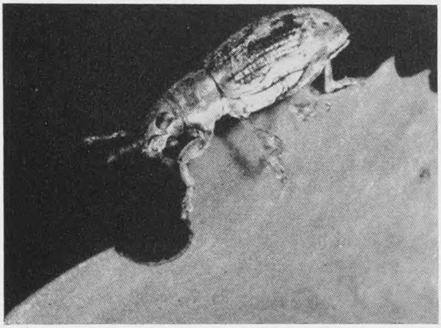
LIFE-HISTORY

The sweetclover weevils overwinter as adults under trash and clods of dirt in the field where they were feeding. When the dormant buds of the sweet clover begin to show green in the spring, they become active and feed on the new foliage. They fly about in search of mates and new fields as well as run on the surface of the ground.

Eggs are laid on the soil surface in May and June and the larvae burrow into the soil, where they feed on the root hairs of the sweetclover plants. They will go as deep as 5 to 6 inches but move to the upper 2 to 3 inches to pupate. New adults emerge in early August and feed actively until the first frosts. The old adults are usually dead before the new generation appears.

DAMAGE

Larval feeding on the roots is of little importance, but adult feeding on the leaves is serious, particularly to seedling plants, which are often killed. Adult weevils have a habit of dropping to the ground and feigning death when disturbed. At such times they are very difficult to see and the crescent shaped feeding notches are the most conspicuous evidence of the presence of the weevil. Second-year plants are often severely defoliated in the spring but can usually outgrow the damage if there is sufficient moisture. New generation adults do not fly but will migrate in army-like formations from second-year fields of sweet clover in which the food plants have been destroyed by tillage. If a first-year field of sweet clover is adjacent, the weevils advance into it and consume all foliage and strip the plants of bark as they advance. Damage may occur for a distance of 30 to 40 yards into the field. Defoliated plants are unable to overwinter.



—Photo R. D. Bird

Adult sweetclover weevil eating a piece out of a sweet clover leaf

CONTROL

The weevils can be controlled by proper cultural practices and by chemicals.

Cultural Control. If the second-year fields of sweet clover are ploughed down, or mowed and cultivated, before the middle of July, larvae and pupae will be destroyed and emergence of large numbers of new adults prevented.

New plantings of sweet clover should not be made close to second-year fields. Fall damage by migrating populations can be prevented by planting the new crop some distance, preferably half a mile, from the previous crop.

Chemical Control. If seedling plants are attacked, prompt chemical application is necessary in order to save the crop. The fall migration of adults into new crop can also be checked by chemical application. Several insecticides are effective. They may be applied in emulsion form by ordinary boom sprayers. The following insecticides are recommended:

2 lb of actual DDT per acre
½ lb of actual dieldrin per acre
1 lb of actual heptachlor per acre

The Alfalfa Weevil

G. A. Hobbs

Field Crop Insect Section

Science Service Laboratory, Lethbridge, Alberta

Dr. Hobbs received his B.S.A. degree at the Ontario Agricultural College, his M.Sc. in Entomology at Utah State Agricultural College, and his Ph.D. in Entomology at Oregon State College. Dr. Hobbs is head of the forage crop insect project at the Lethbridge Science Service Laboratory and has done extensive research on the pollination of legumes and the ecology of bee-pollinators.

This serious pest of alfalfa is now pioneering in southern Alberta; it has not yet made its way to Manitoba. In 1904 the alfalfa weevil, a native of Europe, turned up in an alfalfa field a few miles from Salt Lake City, Utah. Since then, it has gradually made its way north and is now a pest in Idaho, Wyoming, Nebraska, South Dakota, and Montana. On the 50th anniversary of its discovery in North America it was found in very small numbers in alfalfa fields in southern Alberta and southern Saskatchewan. It has now spread to fields throughout the area lying south of the Oldman and St. Mary Rivers in Alberta. So far it has not built up its population to where it is a pest but its spread and increase in Alberta in 1955 indicate that it may become as serious here as it is in Montana. We have been told that, in Montana, it begins to cause serious damage 5 to 10 years after it is first seen and from then on continues to cause serious damage to alfalfa hay and seed fields.

LIFE-HISTORY AND DESCRIPTION

This brown weevil overwinters under the trash in and around alfalfa fields. As soon as new growth appears in the spring the females lay clusters of eggs in the stems of this new growth. Newly hatched larvae are very small, yellow grubs with shiny black heads; they are seldom seen because they climb to the tips of the new shoots and feed between the newly forming leaves and stems. This type of feeding causes severe stunting of the plant. After the larvae have moulted, they move out and feed on the tissues between the veins of the leaves. When you see these skeletonized leaves you will know that the damage was done by the alfalfa weevil. The larvae we see doing this damage are about ⅜ inch long and have light-green bodies and brown heads. When present in sufficient numbers, they will

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Eggs of the alfalfa weevil inside an alfalfa stem

Alfalfa weevil larva feeding on an alfalfa leaf

Pupal stage of the alfalfa weevil

Adult alfalfa weevil

destroy almost all of the leaf surface and the fields will look grey instead of green from a distance. When the larvae are fully grown, they spin round, white, gauze-like cocoons and then become pupae; a week or so later they become adults and leave the cocoons to feed and mate before frost kills the alfalfa and forces them to hibernate for the winter.

CONTROL

Chemical Control. Montana scientists recommend the application of 4 to 6 ounces of actual dieldrin or heptachlor per acre. This should be timed to kill the adult weevils as soon as they become active in the spring and before they have had time to lay eggs that could be protected from the poison by the stem walls. If a good kill is achieved, it may take 2 to 4 years before the weevil can build up to where it will again have to be controlled with an insecticide.

Cultural Control. It is possible that, in these northern areas, larval development will be so slow that the cutting of the crop for hay will deprive most of the larvae of food before they can complete development and will therefore act as a cultural control. As no hay crop is taken from fields left for seed in Western Canada, the weevils will be left to build up more rapidly. Therefore, we will probably have to rely on chemical control for the weevil in alfalfa seed fields, even though we may not have to control it in this manner in hay fields.

Natural Control. When the alfalfa weevil emigrated to America, it left its natural enemies behind. Although it had never been much of a pest in Europe, it soon became a very serious one in America, largely because there were no insect parasites to help control it here. Several species of parasites were imported from Europe and were released in fields infested with the weevil. One of these found climatic conditions to its liking and its numbers increased tremendously at the expense of the weevil. This tiny, wasp-like parasite has also made its way north into Canada and is helping to reduce weevil numbers here. If the poison used to kill adult weevils is applied at the proper time, no harm will be done to these parasites and they will then be left to seek out and destroy the weevil larvae that hatched from eggs laid before the insecticide killed the female weevils.

The victory of success is half won when one gains the habit of work.

—Sarah A. Bolton

Sugar-Beet Nematode

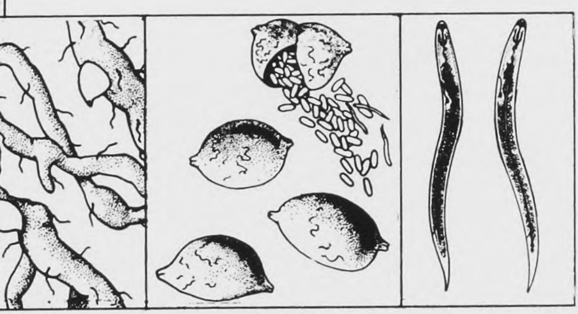
A. M. Harper and G. E. Swailes

Field Crop Insect Section

Science Service Laboratory, Lethbridge, Alberta

The sugar-beet nematode was discovered in Eastern Canada in 1931 but has not yet been found in Western Canadian beet fields.

This pest is well established in Europe, where too-frequent cropping of lands with sugar beets has allowed the nematode population to increase to such an extent that it became necessary to put much of the infested land back to permanet pasture and to close many sugar-beet factories. It is now recognized that much of this trouble could have been avoided if proper preventive measures had been followed. The sugar-beet nematode is present in United States and Eastern Canada in some of the important beet growing areas, but crop losses have been kept to a minimum by a combination of isolation and crop rotation.



—Copied from Div. Ent. Proc. Pub. No. 30, Ottawa, 1945. A. D. Baker

Nematode-infested sugar beet | **Affected beet root (enlarged) showing female nematodes** | **Detached cysts (greatly enlarged)** | **Larvae of nematodes (greatly enlarged)**

CROPS ATTACKED

Sugar beets are the favorite host but other crops are also attacked, including cabbage, cauliflower, garden beet, turnip, mangel, spinach, brussels sprouts, radish, broccoli, and rape. Mustard, stinkweed, curled dock, and lambsquarter are among the common weeds attacked.

DESCRIPTION

A common sign of sugar-beet nematode infestation in a beet field is the presence of small patches where the plants are stunted and unhealthy. If nematodes are sufficiently numerous in these areas the beets may not survive and bare patches will be evident.

The outer leaves of an infested beet plant tend to wilt, change color and die. **The central leaves may remain green** but they are usually small and more numerous than those of heathy plants. If a plant is not too severely attacked, the green foliage may increase later in the season but the root will be stunted. The injured beet is easily pulled from the soil, as it is smaller than normal and the tap root is comparatively short. **There is a greatly increased development of small lateral rootlets giving a whiskered appearance to the root.**

If infected beet roots are examined closely any time after the latter part of June, the extremely small, white, lemon-shaped bodies of the female may be observed clinging to the roots. At first they look like tiny pearls but later they turn brown and eventually drop off into the soil. These brown cases are the "cysts," which contain the eggs of the nematode. Each of these cysts may contain several hundred eggs, and the roots of a single infested beet may contain many cysts. The presence of these cysts is the most definite indication of the presence of the nematode.

PREVENTION OF SPREAD

The main point to remember is not to move any soil from an infested field to one that is not infested.

Flood waters moving from infested to uninfested lands will spread the sugar-beet nematodes. High winds will also move top soil, and nematodes with it, if the ground is dry and loose.

Potatoes grown on infested land should not be used for seed on clean land, as cysts of these nematodes may be carried on soil adhering to the tubers even though they do not actually attack this plant.

Any plants intended for transplanting should not be grown on infested land and then moved to clean land. Transporting the soil transports the nematode.

CONTROL

Up to the present time there is no practical treatment that will completely clean up a field infested with sugar-beet nematode.

Fumigation, although fairly effective, is not practical on a large scale.

When sugar beets or other susceptible crops have been grown too frequently on an infested field the nematode population reaches an enormous figure. To avoid severe injury, space the susceptible crops widely in the rotation (not oftener than once in three years) to interrupt the nematodes' food supply, so that they will not increase sufficiently to cause important crop loss. Non-susceptible crops that could be used in the rotation include such plants as corn, bean, pea, potato, sweet clover, alfalfa, tomato, onion, wheat, barley, and oats.

Keeping soil fertility high is important, for plants receiving an abundant supply of food have a better chance of withstanding nematode attack.

A great deal of the joy of life consists in doing perfectly, or at least to the best of one's ability, everything which he attempts to do. There is a sense of satisfaction, a pride in surveying such a work — a work which is rounded, full, exact, complete in all its parts — which the superficial man, who leaves his work in a slovenly, shipshod, half-finished condition, can never know. It is this conscientious completeness which turns work into art. The smallest thing, well done, becomes artistic.

—William Matthews

There are obviously two educations. One should teach us how to make a living and the other how to live.

—James Truslow Adams

Insecticides For Crop Protection

S. McDonald

Field Crop Insect Section
Science Service Laboratory, Lethbridge, Alberta

Mr. McDonald obtained his B.Sc. and M.Sc. in Biology from the University of Western Ontario. He worked on the spruce budworm with the Forest Biology Laboratory at Sault Ste. Marie, Ontario, before coming to Lethbridge. Mr. McDonald is now conducting chemical control studies on insects in southern Alberta.

Within recent years several relatively cheap but powerful new insecticides have made possible the economic control of most insect pests. Through the proper use of these new chemicals, growers have been able to increase the yield and quality of their produce.

Efficient chemical control depends on a knowledge of the habits and seasonal development of pest insects. The farmer must detect the presence of pest insects in his fields at relatively early stages. This requires close observation throughout the season and is important in order that insecticides may be applied before serious insect damage has occurred and at a time when the insects are readily killed.

The proper method of applying insecticides is also important. Insects are killed by direct contact with the insecticide or by eating treated food. The grower should be aware of this and endeavour to apply insecticides with maximum coverage and follow all recommendations to the letter.

Not all insects can be controlled effectively with insecticides, but their numbers may be reduced through biological or cultural methods. Likewise, those species for which chemical control is recommended can often be more effectively destroyed and at a lower cost if insecticidal control is co-ordinated with good cultural practices.

Insecticides should not be considered "cure-alls" but should be used as tools to protect crops from serious damage.

HAZARDS OF INSECTICIDES

Insecticides are poisons. Although these chemicals have been developed to kill insects, they are dangerous when handled

carelessly. **Humans and other warm-blooded animals can be poisoned accidentally by swallowing the insecticide, by eating insecticide-contaminated food, or by prolonged exposure to dusts and sprays.** Continued exposure to small quantities may not kill a person but may cause damage to the liver and other organs and may accumulate in the fat and milk of domestic animals. All insecticides are not equally hazardous to warm-blooded animals. The following table gives the comparative amounts of insecticides required to cause death when taken by mouth:

Chemical	Approximate weight of actual chemical required to cause death when taken by mouth	
	200-lb man	1,000-lb steer
	oz.	oz.
Piperonyl butoxide	36.8	184.0
Methoxychlor	19.2	96.0
Malathion	1.6	8.0
Chlordane	1.4	7.2
DDT	0.8	4.0
Pyrethrine	0.6	3.2
Rotenone (derris)	0.4	2.0
Lindane	0.4	1.9
Heptachlor	0.3	1.4
Dieldrin	0.25	1.2
Toxaphene	0.2	1.0
Aldrin	0.2	1.0
Nicotine	0.19	0.9
Paris green	0.06	0.3
Calcium arsenate	0.06	0.3
Parathion	0.01	0.05

HANDLING AND USING INSECTICIDES

Read the instructions on the label of the container carefully. Insecticides sold in Canada must be registered in accordance with the provisions of the Pest Control Act. Under the regulations of this act, the ingredients, guarantees, purpose of product, directions for use, and labels are reviewed by the Department of Agriculture before the product is registered. Hence, insecticides may be used with confidence if the directions of the manufacturer are followed.

The following precautions should be strictly observed when using or handling insecticides:

1. Wear protective clothing, such as coveralls and rubber gloves.
2. Change contaminated clothing as soon as possible and wash before re-use.

3. Do not smoke, especially hand-rolled cigarettes, while spraying or dusting.
4. If insecticides are spilled on the skin, wash immediately and thoroughly with soap and water.
5. Avoid breathing in sprays or dusts.
6. Avoid prolonged exposure to insecticides.
7. Wash hands and face after spraying or dusting.
8. Be careful not to contaminate feed or water for livestock and observe all cautions on labels when using treated crops.
9. Keep insecticides out of reach of small children, pets, or irresponsible persons.
10. Keep insecticides in the original containers with the proper labels.
11. Destroy all empty containers by burning if possible and avoid smoke from such fires.
12. Store insecticides in a safe place and away from food or where food is handled.
13. Equipment used for insecticides should be thoroughly rinsed after use to avoid unnecessary clogging and decomposition.

ACCIDENTAL POISONING

If symptoms such as blurred vision, headache, tightness of chest, or nausea are noticeable after exposure to insecticides, **call a physician at once** or **take the victim to a hospital immediately.** Be certain what insecticide was used. Take the label of the container to the doctor, as the antidote is clearly marked on all container labels.

INSECTICIDE FORMULATIONS

Insecticides are usually marketed for field crop use in three forms: as emulsifiable concentrates, as wettable powders, and as dusts.

Emulsifiable Concentrates. These are solutions containing an insecticidal chemical dissolved in a solvent or oil with an added emulsifying agent. Such concentrates form emulsions when added to water. These do not settle out readily and can be sprayed with low-pressure equipment.

Wettable Powders. These are finely divided dust particles that have been impregnated with an insecticide and to which a wetting agent or emulsifying agent has been added. The wetting agent permits the dust particles to be suspended in water. These suspensions require constant agitation and can be used only through piston or diaphragm pump systems, as they cause severe wear in gear-type pumps and clog low-pressure nozzles.

Dusts. These are finely divided particles of an insecticide that are impregnated on or mixed with an inert carrier such as talc. They can **not** be mixed with water and used for spraying but must be applied with a dust applicator. Coarse forms are marketed as granular insecticides and are replacing dusts for mixing with fertilizer.

HOW TO CALCULATE AMOUNT OF INSECTICIDE REQUIRED

Most chemical control recommendations are given in pounds of actual chemical per acre. When using dusts or wettable powders it is necessary to convert these rates into pounds of the percentage formulation being used. The following table can be used for converting these recommendations:

Pounds of prepared dusts and wettable powders equivalent to pounds of actual chemical

Recommended rate of actual chemical per acre	Equivalent amount, in pounds, of prepared mixture						
	2.5%	5%	10%	15%	20%	25%	50%
4 oz.	10	5	2½	1⅔	1¼	1	½
8 oz.	20	10	5	3⅓	2½	2	1
1 lb	40	20	10	6⅔	5	4	2
3 lb	120	60	30	20	15	12	6
5 lb	200	100	50	33⅓	25	20	10
7 lb	280	140	70	46⅔	35	28	14
10 lbs	400	200	100	66⅔	50	40	20

Emulsifiable concentrates can be sold as percentage solutions (1 gallon of 50% emulsifiable concentrate contains 5 pounds of actual chemical). In other instances the label on the container will specify the weight of actual chemical per gallon of emulsion.

APPLICATION OF INSECTICIDES

Insects in the Soil

Broadcast Soil Treatment. Insecticides may be applied to the surface of the soil by broadcasting a dust or granular formulation or by spraying insecticide-water solutions. In either case the operation can be done on summer-fallow or just before planting but should be followed immediately by cultivation to a depth of 3 to 4 inches. A proper mixing of the soil and the insecticide is essential, This treatment, though initially more expensive than other methods, will give satisfactory control for a longer period of time.

Side Dressings. This method, which is recommended for some insects attacking row crops, consists in applying the insecticide in bands along one or both sides of the crop row. The insecticide may

be applied in the following forms: liquid, dust, granular formulations, or insecticide-fertilizer combinations. It must be well mixed with the soil as it is applied.

Seed Treatments. The purpose of an insecticide seed dressing is to protect the germinating seed and emerging seedling from being destroyed or weakened by insect attack. A small quantity of the insecticide is applied on the seed coat either as a dust with a sticking additive or as a liquid. This coating gives protection during the initial growth period only and kills those insects that come in contact with the treated seed. This method may not reduce the insect population sufficiently in the year of application to ensure the absence of insect damage the following season, especially where row crops such as sugar beets or potatoes follow treated grain in rotation.

Insects on Foliage

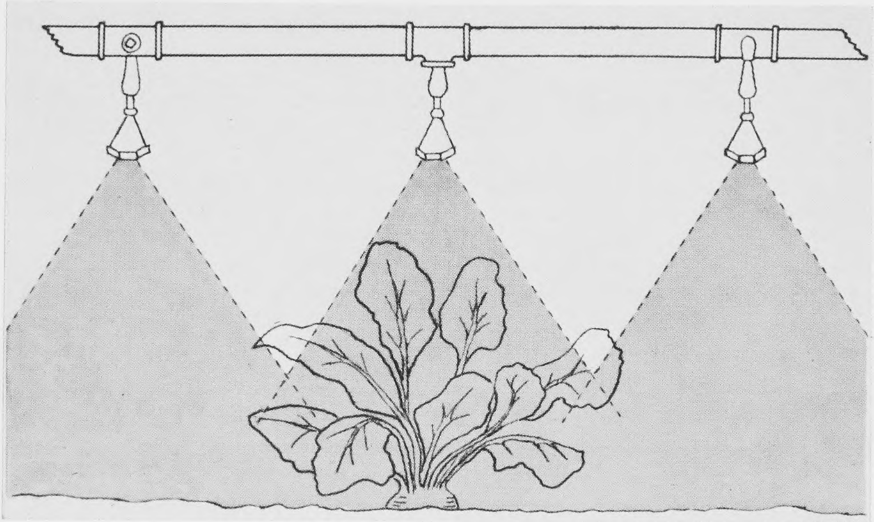
Spraying and Dusting. Insects that feed on the above-ground portion of a plant can be controlled by spraying emulsions, or wettable powders, and by applying dusts. It is important that proper coverage be obtained, especially on the undersides of the leaves, and that all chemical control recommendations are followed very closely. To minimize loss of insecticide due to drifting, spraying and dusting should never be undertaken during a strong wind. Such operations can be accomplished more effectively in the early morning or late evening when there is little or no wind. If possible, all spraying and dusting should be carried out at right angles to the direction of the wind, not with or against the wind. This will help to minimize losses from drifting and protect the operator from prolonged exposure to the insecticide.

APPLICATION EQUIPMENT

Power-operated dusters or sprayers that give a uniform coverage are essential if chemical control is to be obtained with a minimum cost.

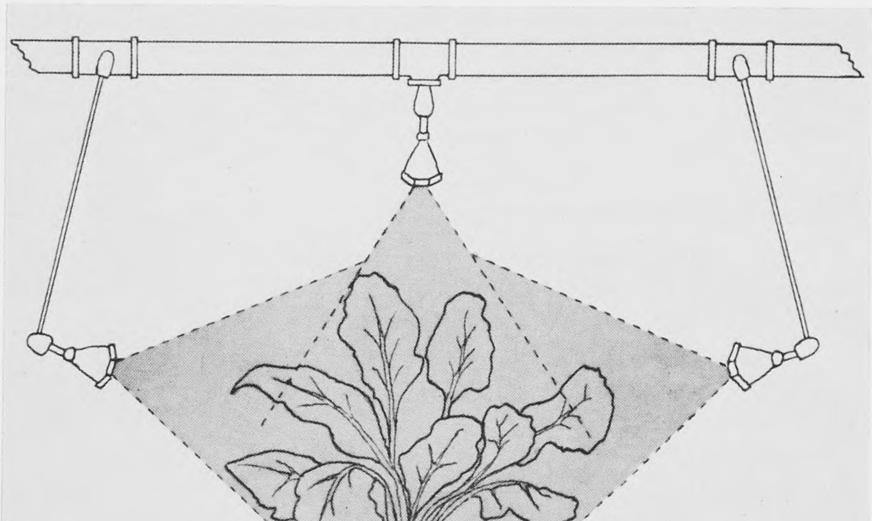
Low-Volume, Low-Pressure Sprayers. This equipment, which is used extensively for weed-killers, can be used to spray emulsifiable concentrates but is **not** built for use with wettable powder suspensions.

If equipped with a conventional weed-spraying boom, this type of sprayer is efficient for general broadcast applications, such as applying liquid insecticides to the soil surface or on closely planted cereal crops, and can be used to apply insecticides to young row crops where an under-leaf spray is not necessary. However, for mature row crops a specialized boom, such as that used on a potato sprayer, is essential to concentrate the insecticide along the row and to get coverage on the undersides of the leaves. When using low-



—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Weed Spray Boom. Spray is directed on the top of the plant only, resulting in very little under-leaf coverage



—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Row Crop Spray Boom. Spray is directed on the top and sides of the rows to develop turbulence within the plants. Spray materials cover all surfaces of leaves and stems

volume, low-pressure sprayers for applying insecticides the delivery rate should be approximately 5 to 10 gallons per acre to ensure dispersal of the insecticide.

The same sprayer should not be used for insecticides and herbicides if the crops being treated are susceptible to weed-killers. Contamination of spraying equipment by herbicides is almost impossible to eliminate, and many valuable crops have been severely damaged by insecticide sprays containing traces of weed-killers.

High-pressure Sprayers. High-pressure or piston-type sprayers are most versatile and are preferred for insecticide application. These are suitable for spraying both wettable powders and emulsions. These all-purpose sprayers can be used with emulsions at low pressures when equipped with weed-type or row-crop booms or at high pressures using wettable powders. When equipped with a spray gun they are suitable for spraying livestock, barns, corrals, and shelter belts.

Dust Applicators. All power-driven row-crop dusters will apply dusts uniformly, but calm conditions are essential. The efficiency of dusting can be increased, especially on mature crops, if a canvass is pulled immediately behind the dust boom. The fertilizer attachment on most seed drills can be used quite effectively when dust or granular formulations are being applied for the control of soil insects.

—Photo Can. and Dom. Sugar Company

Sugar-beet field being dusted for flea beetles

Small Aircraft. Aircraft can be used for applying insecticide sprays or dusts to field crops. Application by aircraft is often more efficient and economical than conventional methods, when crops are mature and subject to injury from ground equipment.

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Aerial spraying for aphids near Lethbridge, Alberta

CLEANING A CONTAMINATED SPRAYER

Sprayers that have been contaminated with herbicides can be used for insecticides without danger to susceptible crops provided the following cleaning procedures are carried out:

1. Fill and flush out the sprayer three times using clean water.
2. Fill the tank with a mixture of warm water and household ammonia (1 cup ammonia to 3 gallons water). Allow this mixture to stand in the tank for 1 to 2 days and then run it through the machine. More rapid results can be obtained if household ammonia is used with steam.
3. Wash out the sprayer with soapy water and rinse again with clean water.

Genius begins great works, labor finishes them.

—Joubert

Diseases of Sugar Beets in the Prairie Provinces

F. R. Harper and M. W. Cormack

Plant Pathology Section

Science Service Laboratory, Lethbridge, Alberta

Mr. Harper graduated from the University of Alberta with his B.Sc. in Agriculture and expects to complete his M.Sc. in Plant Pathology at the same university in 1956. He has been studying diseases of specialized irrigated crops.

Dr. Cormack is Officer-in-charge of the Plant Pathology Section of the Science Service Laboratory at Lethbridge. He obtained his B.S.A. from the University of Manitoba, his B.Sc. and M.Sc. from the University of Alberta, and his Ph.D. in Plant Pathology from the University of Minnesota. Dr. Cormack has published numerous papers on diseases of forage crops in Alberta and is at present studying bacterial wilt and snow mould.

The sugar-beet fields of the prairie provinces are, fortunately, free from many of the destructive diseases found in other parts of North America. Curly top and Cercospora leaf spot, which caused serious losses in sugar-beet-growing areas of the United States, have not been found here. Virus yellows, a serious disease of sugar beets in Europe, has not yet been found in either Alberta or Manitoba although it has recently been found in United States. Root diseases, however, occur here each year and frequently cause losses.

BLACK ROOT

Black root, or seedling blight, caused by soil- and seed-borne fungi is present in all sugar-beet fields every year, but in general does little damage. Although this disease is mainly confined to seedlings from germination to the 6-leaf stage, damage may continue throughout the season.

Symptoms

Black-root-affected plants are characterized by a brown or brownish-black discoloration of the root. This discoloration may appear as a narrow band or may completely envelop the root and part of the seedling stem above the surface of the ground. Diseased plants usually become stunted and may eventually die, although those not severely attacked will recover and produce a crop. Plants that have been attacked do not usually produce as good roots as those that are disease-free.

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Sugar-beet seedlings showing various degrees of black root damage. Left to right: healthy, slightly damaged, severely damaged, and dead

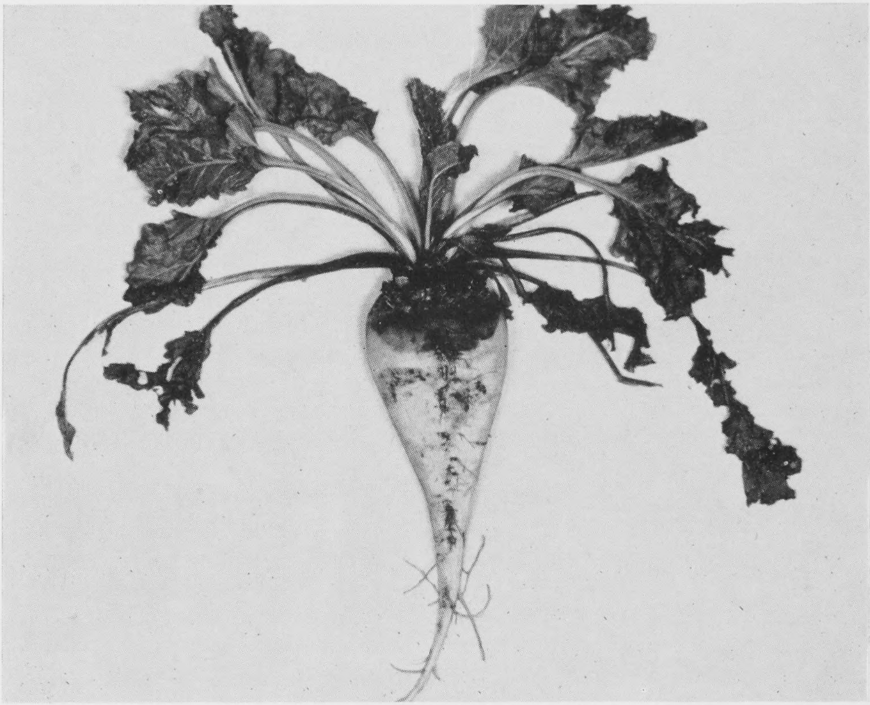
Control

Cultural Control. Proper crop rotation and soil preparation should be practised. Legume sod should be ploughed under early enough the previous season so that the residue will be well decomposed before seeding. Using the same soil for sugar beets two years in succession should be avoided, as this allows the causal fungi to build up and cause greater damage the second year.

Application of a fertilizer containing both nitrogen and phosphate enables the seedlings to make a good start and escape injury from black-root.

If black root is serious it is advisable to delay thinning until the plants are in the 6-leaf stage so that stunted and weak plants can be easily recognized and thus eliminated.

Chemical Control. Seed treatment may be helpful in protecting seedlings during the time they are most susceptible, although seed treatment alone will not prevent black root damage. **Treated seed is generally supplied to the growers by the sugar company.**



—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

Sugar beet damaged by root rot

ROOT ROTS

The root rot damage sometimes found in sugar-beet fields in July and August is generally caused by the same fungi that cause black root. Affected roots exhibit light to dark-brown rotted areas varying in diameter from ½ inch to 2 or 3 inches. The rotting may involve only the surface layer or it may penetrate an inch or more

into the beet. Root rot is often found in fields that were damaged earlier by black root or that have a fairly high root aphid infestation.

Rhizopus root rot is a distinct type of root rot often seen in low-lying areas. This disease is first noted as a wilting and yellowing of the leaves followed by collapse and death of the older leaves. Roots of the affected plants are often badly decayed and have a grey to grey-brown discoloration and, frequently, an offensive odor. This root rot is caused by a fungus that can attack sugar beets only when conditions are extremely unfavorable for root growth.

Control

There is no effective chemical control against root rots. Maintaining the beets under conditions favorable for healthy growth is the only means of preventing root rot losses. Measures recommended for control of root aphids and other sugar-beet insects may also aid in reducing root rot damage. As rhizopus root rot is associated with inadequate drainage, do not plant beets on low-lying land subject to flooding.

WIND INJURY

Strong winds whipping recently thinned sugar-beet seedlings can cause a type of injury that is easily confused with black root or insect damage. Injured plants wilt and die. Affected plants have a constriction of the root at ground level with the root and top held together by only a thin band of dead tissue. Wind injury can be reduced by avoiding thinning young stands during severe wind storms.

VIRUS YELLOWS

Virus yellows, one of the most serious diseases of sugar beets in Europe, has recently been found in some sugar-beet-growing areas of United States and it could become established in Western Canada. For this reason all growers should become familiar with the symptoms of this disease. The first symptoms, which generally appear in June or July, are a thickening of the older leaves and a gradual change in color to a bright yellow or orange. Later these leaves become quite brittle and tend to develop small red or brownish dots, or "freckles", over the leaf surface.

The virus that causes this disease is spread by a species of aphid which is very common in Western Canada.

Control

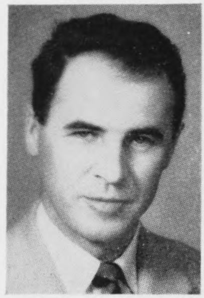
No effective control measures are yet known for this disease once it becomes established in an area.

Crop Rotation

G. C. Russell and S. Dubetz

Canada Experimental Farm, Lethbridge, Alberta

Dr. Russell obtained the degree of B.Sc. in Agronomy at Brigham Young University and an M.Sc. degree in Soil Chemistry at the University of Massachusettes. He completed further studies in soil chemistry at Purdue University and received a Ph.D. degree in 1952. Dr. Russell is head of Field Husbandry at the Canada Experimental Farm, Lethbridge, and has made notable contributions in the field of soil fertility.



Mr. Dubetz obtained his B.Sc. in Agriculture at the University of Alberta and is at present completing requirements for his M.Sc. degree at Utah State Agricultural College. Mr. Dubetz is in charge of Irrigated Field Husbandry at the Canada Experimental Farm, Lethbridge, and is at present engaged in specialized studies concerning sugar beet production.

Much of the success of a business venture can be attributed to the planning that has gone into its organization. Farming enterprises are no exception and require as much careful planning as any other business. This is especially true of diversified farming, where experience has shown that farmers following a definite rotation produce more sugar beets than farmers following no rotation. (See SILVER SUNSHINE, Fall Issue, 1955, page 6.) Since the purpose of proper farm management is to maintain or improve yields, consideration should be given in planning to (1) the control of disease and insect pests, (2) the maintainence of soil fertility, and (3) the control of weeds.

From the standpoint of control of plant diseases and insects, crop rotations are effective under certain conditions. Many plant disease organisms increase to serious proportions only in the presence of certain host plants. When suitable host plants are not present, the organisms are unable to compete with the regular soil inhabitants and gradually disappear. Land infested with the sugar-beet nematode soon builds up a destructive population when beets are planted for several successive years. Organisms that only become a menace under such conditions can best be controlled by crop rotations, which limit the occurrence of host plants to infrequent positions in the crop sequence. Some of the larger insects may be controlled in the same manner. The alfalfa weevil, for example, which attacks both alfalfa

and peas, will not live over in any numbers in rotations including many of the row crops and small grains.

—Photo Section, Can. Dept. Agric., Lethbridge, Alberta

General view of some of the rotation plots at the Experimental Farm, Lethbridge

Frequently the increased biological activity in the soil resulting from the use of manures in rotations, or from the incorporation of crop residues into the soil, will depress the activity of some harmful organisms. It has also been shown that the dominant groups of soil organisms in the root zone vary from crop to crop, suggesting that rotations may exert some control over disease-causers in the soil by encouraging the growth of microbial groups antagonistic to harmful organisms.

Of primary importance in rotation planning is the selection of the crops to be grown and the arranging of the selected crops in a sequence most favourable to all crops. The choice of crops depends on a number of factors, such as the availability of contracts, the labour situation, the location of the farm with respect to processing and marketing agencies, and the personal preference of the farmer. Successful rotations may vary from district to district and from farm to farm within a district. The value of legume crops in rotations has been demonstrated, and the use of hay and pasture crops along with grain and sugar beets has been profitable in some areas.

Frequently the sequence of crops within a rotation has an important effect on total production. The beneficial effect of alfalfa on succeeding crops is well known. That sugar beets produce well after dry beans, canning peas and potatoes is shown by results of an experiment reported in Table 1. Canning corn and wheat could follow any of the other crops shown in Table 1 without seriously

TABLE 1. Four-year (1948-1949, 1952-1953) average crop yields[1] and calculated gross returns following different preceding crops and summer-fallow in a crop sequence test. Experimental Farm, Lethbridge.

Crop	Preceding Crop							Grown After Fallow[2]
	Barley	Beans	Corn	Peas	Potatoes	S. Beets	Wheat	
Barley - bu. per acre	67.8	84.5	72.4	75.5	76.6	73.4	69.6	74.0
Gross returns @ 90c per bu.	$61.02	76.05	65.16	67.95	68.94	66.06	62.64	66.60
Beans - ℔ per acre	1564	2012	1663	1663	1863	1553	1540	1856
Gross returns @ 8c per ℔	$125.12	160.96	133.04	133.04	149.04	124.24	123.20	148.48
Canning Corn - tons per acre	6.68	7.10	6.98	7.38	7.38	6.72	6.45	7.14
Gross returns @ $20 per ton	$133.60	142.00	139.60	147.60	147.60	134.40	129.00	142.80
Canning Peas - tons per acre	1.71	2.09	1.83	1.89	1.91	1.72	1.71	1.86
Gross returns @ $95 per ton	$162.45	198.55	173.85	179.55	181.45	163.40	162.45	176.70
Potatoes - tons per acre	7.54	8.65	9.26	8.76	6.50	8.16	8.72	9.47
Gross returns @ $25 per ton	$188.50	216.25	231.50	219.00	162.50	204.00	218.00	236.75
Sugar Beets - tons per acre	10.66	12.97	11.62	12.26	12.58	10.67	10.98	16.12
Gross returns @ $14 per ton	$149.24	181.58	162.68	171.64	176.12	149.38	153.72	225.68
Wheat - bu. per acre	47.4	53.2	49.6	48.4	51.1	46.8	50.0	52.8
Gross returns at $1.60 per bu.	$75.84	85.12	79.36	77.44	81.76	74.88	80.00	84.48
Average gross returns per acre per year	$127.97	151.50	140.74	142.32	138.20	130.91	132.72	77.25

[1] Data are based on means of yields from replicates at four locations.

[2] Two-year averages only.

affecting yield. The experimental result also indicates that summer-fallowing irrigated land is not justified on the basis of comparative yearly gross returns unless a weed problem or a land-levelling program makes it necessary to keep the land out of a crop.

The success of any farming program is dependent largely on the fertility and physical condition of the soil. By maintaining or improving the fertility of the soil, a farmer increases his chances for higher profits over a longer period of years. An efficient crop planning system incorporates manures and fertilizers into the rotation where they will have the greatest effect on returns. Yield increases at the Experimental Farm resulting from the addition of manure to sugar beet rotations have led to a calculated value for manure of $12 per ton. Inasmuch as manure is of value in increasing yields (Table 2) and improving soil condition, the inclusion of live stock in

TABLE 2. Effect of fertilizer and manure on crop yields. (Twenty-seven-year, 1929-1955, averages from an eight-year rotation.) Experimental Farm, Lethbridge.

Crop	No Additions	Manure[1] Only	Yield Increases due to Manure	Fertilizer[2] Only	Yield Increases due to Fertilizer
Wheat - bu./A	37.8	46.7	8.9	45.6	7.8
Alfalfa - tons/A	1.95	3.48	1.53	2.66	0.71
Alfalfa - tons/A	1.58	3.25	1.67	1.99	0.41
Alfalfa - tons/A	1.67	2.88	1.21	1.61	-0.06
Wheat[1] - bu./A	27.4	33.7	6.3	30.1	2.7
Sugar Beets[2] - tons/A	5.04	19.67	14.63	13.62	8.58
Sugar Beets[2] - tons/A	6.23	18.45	12.22	15.33	9.10
Wheat - bu./A	45.1	52.6	7.5	51.2	6.1

[1] 30 tons of barnyard manure per acre applied to wheat stubble in fall preceding first-year sugar beets.

[2] Ammonium phosphate fertilizer (11-48-0) applied at a rate of 100 pounds per acre with both crops of sugar beets at time of planting.

farm planning warrants consideration. Manure should be applied in sugar beet rotations when it will have its greatest effect on sugar beet production. Best results in southern Alberta have been obtained when the manure was applied during the late summer or early fall of the year preceding sugar beets. Such a practice fits in very well where the beets follow canning peas, canning corn or grain. The manure is applied to the stubble and ploughed under as soon as possible after spreading. Manure may also be worked into the soil during the fallow year where beets occur in a rotation following fallow. An application of 15 tons of manure per acre every four or 5 years has proved very satisfactory.

Phosphorus is necessary to maintain good yields of such crops as sugar beets and alfalfa (Table 2), while it has a less pronounced effect on the yield of grain crops. Therefore, to get the greatest returns, phosphatic fertilizers should be applied to beets or legumes when they occur in rotations. For best results with such crops as beets, peas and beans, the phosphate should be applied with the seed at time of planting. About 100 pounds of 11-48-0 fertilizer per acre should supply sufficient phosphorus for sugar beets. The applications of nitrogen fertilizer should be considered in those areas where such applications have been shown to increase yields.

Well-planned cropping systems, combined with the use of clean seed, are an effective means of controlling weeds. Not all weeds can be controlled by crop rotation, but weed problems are generally less severe on farms where a systematic rotation is practised. Cropping practices may be planned so that cultivation, mowing, grazing or hand-hoeing may be alternated over a period of years to exert maximum damage on a given weed group. For example, Canada thistle can be satisfactorily controlled by growing alfalfa, in a rotation, followed by one of the hand-hoed row crops.

Crop sequence and cultural operations involved in good rotation management may, therefore, aid in the control of disease and insect pests. Where rotations will be of value in the control of organisms described in other articles in this publication, specific mention of this fact will be made in the discussion of control measures.

ACKNOWLEDGMENTS

Dr. C. W. Farstad, as Officer-in-Charge of the Field Crop Insect Section of the Science Service Laboratory, which was responsible for this special "Insect Edition" of SILVER SUNSHINE, wishes to make the following acknowledgments:

To Alex M. Harper for his work in editing and producing this issue.

To Dr. R. D. Bird, of the Field Crop Insect Laboratory, Brandon, and Professor A. G. Robinson, of the University of Manitoba, Winnipeg, for information concerning insects on sugar beets in Manitoba.

To Dr. Bird, of the Brandon Laboratory, and N. E. Kloppenborg and E. T. Gushul, of the Photographic Section, Canada Department of Agriculture, Lethbridge, who provided most of the photographs.

Lethbridge Monthly Precipitation Figures For Fifty-Four Years

EXPERIMENTAL FARM - LETHBRIDGE, ALBERTA

INCHES

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1902	0.67	1.03	0.48	0.02	11.27	5.68	5.95	0.69	0.84	0.02	0.43	0.84	27.92
1903	0.62	0.79	0.89	0.33	2.95	1.12	1.86	3.21	1.60	0.17	0.58	0.70	14.82
1904	0.50	0.90	1.03	0.41	2.86	1.80	0.96	1.19	0.52	0.85	0.03	0.35	11.40
1905	1.45	0.05	0.74	0.56	1.33	2.68	1.44	1.99	0.80	1.13	1.36	0.25	13.78
1906	0.22	0.20	0.54	1.30	8.60	2.31	0.83	4.70	0.16	1.93	0.81	0.88	22.48
1907	1.52	0.30	0.34	1.08	1.14	3.64	1.43	2.30	3.24	0.05	0.14	0.32	15.50
1908	0.27	0.75	0.79	0.69	2.60	7.01	0.42	0.90	0.58	0.57	0.00	0.36	14.94
1909	0.30	0.20	0.50	1.15	4.01	0.82	1.54	0.08	0.47	0.37	0.46	0.42	10.32
1910	0.24	0.83	0.17	0.28	0.79	0.53	0.09	1.07	1.95	0.60	0.41	0.94	7.90
1911	0.70	0.52	0.32	0.82	1.90	4.70	2.27	3.63	4.16	0.57	0.95	0.77	21.31
1912	0.69	0.40	0.44	0.20	0.66	1.73	2.78	1.41	2.61	1.07	0.99	0.23	13.21
1913	0.80	.030	0.42	0.52	1.70	4.70	1.29	1.93	1.65	0.50	0.36	0.00	14.17
1914	1.55	0.96	1.12	0.54	0.29	2.48	0.93	3.59	1.07	2.17	0.63	1.19	16.52
1915	0.50	0.94	0.22	0.04	3.03	4.84	3.44	0.96	1.32	0.96	0.75	0.27	17.27
1916	1.09	0.86	0.90	0.46	3.77	3.54	3.33	2.97	4.66	1.99	0.49	0.51	24.57
1917	0.73	0.27	0.10	1.57	0.95	1.42	1.37	2.00	1.67	0.82	0.00	1.13	12.03
1918	0.46	0.76	0.66	0.13	0.58	0.76	0.85	1.23	1.07	0.24	0.43	0.46	7.63
1919	0.06	0.95	0.75	0.47	1.75	0.56	1.06	1.05	2.04	1.78	1.26	0.55	12.28
1920	0.84	1.21	0.89	4.37	1.66	0.40	2.59	0.20	0.05	0.99	0.06	0.79	14.05
1921	0.56	0.47	1.42	1.19	0.96	1.04	3.23	0.46	1.29	0.23	1.73	0.19	12.77
1922	0.43	0.41	0.81	2.57	0.89	1.87	2.30	0.40	0.81	0.78	0.47	0.60	12.34
1923	0.48	0.42	0.75	1.09	3.48	4.45	2.55	1.01	0.18	0.55	0.53	0.91	16.40
1924	0.66	1.04	0.69	0.56	1.17	3.82	0.54	2.91	1.46	0.59	1.02	1.54	16.00
1925	0.30	0.99	2.26	1.99	0.43	3.40	0.82	1.85	4.86	1.08	0.16	0.62	18.76
1926	0.26	0.70	0.11	0.34	0.64	4.67	1.15	2.31	4.62	0.31	0.52	0.56	16.19
1927	0.31	1.39	0.37	1.48	7.32	1.60	1.93	1.74	3.29	0.58	2.88	0.96	23.85
1928	0.94	0.79	0.93	1.32	0.09	6.79	3.98	1.54	0.24	0.85	0.28	0.33	18.08
1929	1.08	0.63	1.34	2.55	2.63	3.72	0.52	0.59	2.05	2.20	0.49	1.91	19.71
1930	0.37	0.20	0.77	1.53	1.54	1.42	1.87	0.57	2.36	0.58	0.92	0.21	12.34
1931	0.01	0.25	1.40	1.12	1.22	1.55	1.09	0.19	1.99	0.66	1.21	0.73	11.42
1932	0.81	0.55	1.05	2.73	2.99	2.06	0.74	3.63	1.00	1.07	1.87	0.74	19.24
1933	0.33	0.38	2.51	2.49	1.80	1.32	0.92	2.64	1.30	2.44	0.77	2.27	19.17
1934	0.43	0.31	2.30	0.13	0.71	4.00	0.43	0.60	2.97	1.70	1.11	0.59	15.28
1935	0.47	0.72	1.09	2.46	1.42	0.35	0.70	1.18	0.22	1.70	0.52	0.47	11.30
1936	1.19	0.62	0.98	0.78	2.01	1.89	0.41	0.90	1.39	0.69	0.48	1.40	12.74
1937	1.76	0.42	0.79	0.45	2.38	3.19	2.91	0.86	1.10	1.33	0.70	0.38	16.27
1938	0.91	0.80	1.85	0.88	3.21	1.16	1.28	1.72	0.81	0.96	1.93	0.22	15.73
1939	0.12	0.88	0.74	0.68	1.66	6.42	0.58	0.38	2.10	0.96	0.29	0.82	15.63
1940	0.03	1.43	0.63	3.47	1.32	1.25	1.72	0.39	1.57	1.37	1.03	0.38	14.59
1941	0.96	0.68	0.71	1.09	1.96	2.67	4.09	1.80	2.82	0.25	0.36	0.34	17.73
1942	0.11	1.21	0.64	1.06	4.61	4.34	3.22	1.00	1.49	0.20	1.44	0.26	19.58
1943	1.06	0.67	0.83	0.81	1.33	0.90	1.46	1.15	0.83	1.11	0.10	0.03	10.28
1944	0.10	1.33	1.08	1.08	1.52	1.76	2.92	1.69	1.05	0.00	2.00	0.57	15.10
1945	0.70	1.33	0.82	1.14	3.18	3.48	1.17	0.88	3.26	0.51	0.91	1.65	19.03
1946	0.54	0.29	0.30	0.43	2.18	4.43	1.01	1.49	1.97	4.37	2.51	1.48	21.00
1947	0.77	1.41	2.10	1.61	0.56	4.24	0.35	2.77	3.45	0.96	1.01	0.72	19.95
1948	0.90	1.68	1.39	1.14	4.24	6.06	2.02	0.10	0.00	0.52	0.55	0.35	18.95
1949	1.62	0.91	1.63	0.15	3.70	1.30	0.96	0.46	0.62	2.55	0.08	1.46	15.44
1950	1.15	0.32	1.51	1.00	0.91	1.33	1.77	0.78	0.89	0.97	1.20	0.59	12.42
1951	1.18	0.99	1.17	2.74	1.28	6.28	0.94	3.74	2.14	2.46	0.15	2.12	25.19
1952	0.69	0.55	1.12	0.20	1.65	2.51	2.03	2.58	0.35	0.27	0.51	0.04	12.50
1953	0.84	2.17	1.73	3.14	0.90	8.17	0.65	0.26	0.88	0.09	0.07	1.04	19.94
1954	1.63	0.41	1.20	1.42	1.12	2.16	0.77	5.02	3.70	0.08	0.29	0.23	18.03
1955	0.66	1.89	0.68	1.90	5.10	1.48	3.87	0.23	0.90	0.66	0.66	0.89	18.92

54-YEAR AVERAGE

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
0.70	0.77	0.94	1.18	2.30	2.92	1.69	1.57	1.67	0.97	0.76	0.71	16.18

FROST DATA - 1902 - 1955 (inclusive)

EXPERIMENTAL FARM - LETHBRIDGE, ALBERTA

Year	Last Frost in Spring Date	Temp. °F	First Frost in Fall Date	Temp. °F	No. of Frost Free Days	Last Killing Frost in Spring Date	Temp. °F	First Killing Frost in Fall Date	Temp. °F	No. of Crop Days
1902	May 9	32.0	Aug. 29	31.9	112	Apr. 25	20.5	Sept. 20	27.5	148
1903	May 22	29.6	Sept. 13	31.1	114	May 21	26.0	Sept. 30	26.5	132
1904	May 25	29.9	Sept. 13	27.1	111	Apr. 18	25.0	Sept. 13	27.1	148
1905	May 19	32.0	Sept. 30	28.8	134	May 5	28.0	Oct. 10	24.8	158
1906	May 27	32.0	Aug. 25	31.2	90	May 8	28.0	Oct. 21	23.0	116
1907	May 13	23 0	Sept. 11	31.9	121	May 13	23.0	Sept. 13	24.2	123
1908	May 2	32.0	Sept. 23	32.0	144	Apr. 30	26.5	Sept. 26	19.2	149
1909	May 29	29.8	Aug. 28	29.8	91	May 8	25.4	Sept. 14	26.8	129
1910	June 4	31.6	Aug. 23	31.5	80	May 20	27.4	Sept. 12	26.3	115
1911	May 28	29.6	Aug. 27	29.4	91	May 1	25.2	Sept. 23	26.3	145
1912	June 6	28.3	Sept. 15	23.9	101	May 4	24.5	Sept. 15	23.9	134
1913	May 12	29.2	Sept. 12	32.0	123	May 6	24.8	Sept. 24	26.2	141
1914	May 12	29.8	Sept. 15	31.0	126	May 11	24.1	Oct. 7	20.1	149
1915	May 16	30.8	Sept. 11	31.2	118	Apr. 11	28.0	Sept. 12	26.5	154
1916	May 23	31.6	Sept. 14	31.2	114	May 13	25.0	Sept. 28	24.0	138
1917	June 4	31.0	Sept. 1	32.0	89	May 30	28.0	Sept. 29	27.0	122
1918	June 6	32.0	Sept. 15	28.0	101	May 26	21.0	Sept. 15	28.0	112
1919	June 1	31.0	Sept. 26	32.0	117	May 14	27.0	Sept. 29	26.0	138
1920	June 3	29.0	Sept. 19	30.0	108	May 30	26.0	Sept. 26	24.0	119
1921	May 31	30.0	Sept. 9	32.0	101	May 28	24.0	Sept. 15	28.0	110
1922	May 23	29.0	Oct. 2	32.0	132	May 6	28.0	Oct. 11	21.0	158
1923	May 29	29.5	Sept. 11	29.0	105	May 15	28.0	Sept. 22	25.0	130
1924	May 26	31.5	Sept. 20	28.5	117	May 6	25.5	Sept. 26	26.0	143
1925	May 17	30.0	Sept. 20	25.5	126	May 11	24.0	Sept. 20	25.5	132
1926	June 9	32.0	Sept. 11	30.0	94	May 2	28.0	Sept. 20	26.0	141
1927	May 18	32.0	Sept. 8	32.0	113	May 9	26.0	Sept. 26	29.0	140
1928	May 14	31.0	Aug. 14	31.0	92	Apr. 22	28.0	Sept. 8	26.0	139
1929	May 19	32.0	Sept. 6	28.0	110	May 15	24.0	Sept. 6	28.0	114
1930	May 23	32.0	Sept. 23	32.0	123	Apr. 21	29.0	Oct. 15	17.0	177
1931	May 21	32.0	Sept. 14	32.0	116	May 19	28.0	Sept. 23	25.0	127
1932	May 28	31.0	Sept. 3	32.0	98	May 15	29.0	Sept. 21	29.0	129
1933	May 20	30.0	Sept. 24	32.0	127	Apr. 20	20.0	Sept. 26	27.0	159
1934	May 12	32.0	Sept. 14	29.0	125	May 2	28.0	Sept. 20	21.0	141
1935	May 28	32.0	Sept. 26	21.0	121	May 8	26.0	Sept. 26	21.0	141
1936	Apr. 29	31.0	Sept. 14	32.0	138	Apr. 28	22.0	Oct. 1	23.0	156
1937	May 21	32.0	Sept. 24	30.8	126	May 6	25.1	Oct. 5	27.1	152
1938	May 15	30.4	Oct. 14	27.8	152	May 14	29.0	Oct. 14	27.8	153
1939	May 1	31.2	Sept. 25	32.0	147	Apr. 20	26.3	Sept. 29	29.0	162
1940	Apr. 26	30.0	Oct. 14	23.0	171	Apr. 19	18.0	Oct. 14	23.0	178
1941	May 22	30.0	Sept. 8	29.5	109	May 8	27.5	Sept. 25	26.8	140
1942	May 18	27.2	Sept. 18	28.0	123	May 18	27.2	Sept. 18	28.0	123
1943	June 8	32.0	Sept. 2	31.2	86	May 14	24.0	Sept. 8	27.5	117
1944	May 23	31.0	Sept. 19	30.5	120	May 7	28.0	Sept. 30	27.8	147
1945	May 12	32.0	Sept. 17	32.0	128	May 8	27.0	Sept. 24	30.0	139
1946	May 21	30.5	Sept. 23	25.0	125	May 10	16.0	Sept. 23	25.0	136
1947	May 28	24.0	Sept. 17	29.0	112	May 28	24.0	Oct. 22	19.5	147
1948	May 12	30.0	Sept. 6	30.5	117	May 3	26.0	Sept. 24	26.0	144
1949	June 18	32.0	Sept. 11	29.5	85	May 23	28.0	Sept. 12	21.0	112
1950	May 8	26.0	Sept. 11	29.5	126	May 8	26.0	Sept. 13	27.5	128
1951	June 27	31.0	Sept. 15	32.0	80	June 1	26.0	Sept. 24	26.5	115
1952	May 9	32.0	Oct. 4	26.0	148	Apr. 23	28.0	Oct. 4	26.0	164
1953	May 21	30.0	Sept. 26	29.0	128	May 13	26.0	Oct. 1	22.5	147
1954	May 14	30.5	Sept. 29	29.0	138	May 7	26.0	Oct. 5	28.0	145
1955	May 25	31.0	Sept. 10	30.0	108	May 17	27.0	Sept. 23	28.0	129
54 - YEAR AVERAGE	May 22		Sept. 15		116	May 9		Sept. 26		140

SILVER SUNSHINE

Published by the Agricultural Department

CANADIAN SUGAR FACTORIES LIMITED

F. R. TAYLOR	J. G. SNOW	M. C. VANCE	K. E. PILLING - R. B. EVANSON
Editor	Asst. Editor	Prod. Mgr.	Production Assistants

INDEX

	Page
Editorial	1
Functions of Field Crop Insect Section of the Science Service Laboratory	5
Some Facts About Insects:	
Damage by Insects	7
Benefits from Insects	8
How Insects Feed	8
Control of Insects	8
Sugar-beet Webworm	10
Sugar-beet Root Aphid	12
Sugar-beet Root Maggot	16
Wireworms	19
Flea Beetles	24
Spinach Carrion Beetle	26
Cutworms	28
Spinach Leaf Miner	31
False Chinch Bug	33
Color Plates	34 - 35
Blister Beetles	36
Grasshoppers	38
The Sweetclover Weevil	41
The Alfalfa Weevil	43
Sugar-beet Nematode	46
Insecticides for Crop Protection:	
Hazards of Insecticides	49
Handling and Using Insecticides	50
Accidental Poisoning	51
Insecticide Formulations	51
How to calculate Amount of Insecticide Required	52
Application of Insecticides	52
Application equipment	53
Cleaning a Contaminated Sprayer	56
Diseases of Sugar Beets in the Prairie Provinces:	
Black Root	57
Root Rots	59
Wind Injury	60
Virus Yellows	60
Crop Rotation	61
Acknowledgments	65
Precipitation Record	66
Frost Data	67